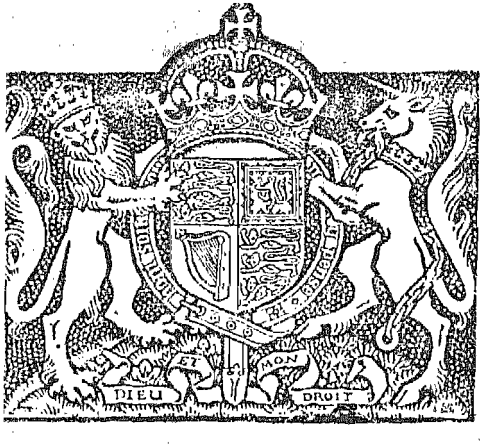

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CLIMATE AND THE ENERGY OF NATIONS

FAIRBANKS HOUSE, DEDHAM, MASSACHUSETTS *Drawing by L. V. Coleman*
One of the oldest houses in the United States (see pp. 151-2)

CLIMATE AND THE ENERGY OF NATIONS

S. F. MARKHAM

OXFORD UNIVERSITY PRESS
LONDON • NEW YORK • TORONTO

First published in England in 1942
First American edition, revised and enlarged, 1944
Second American edition, revised and enlarged, 1947

PRINTED IN THE UNITED STATES OF AMERICA

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CHARTS AND MAPS

PREFACE

In 1931, when Parliamentary Secretary to the Prime Minister, Ramsay MacDonald, I came into his room at the House of Commons one evening and found him most despondent and depressed. It was at the height of the economic crisis, and a National Government had just been formed under his lead. That crisis marked the end of many hopes that he and his colleagues had had of building 'a new Jerusalem in England's green and pleasant land.' 'Government,' he said, 'has become no more than an ambulance, and its success is measured by the speed with which it deals with disaster.'

Those words set me thinking deeply, and a few months later I decided to study the positive factors in building up a great civilization, or the causes of national greatness. I will not weary the reader with the long list of books that were read during a series of world tours during the next five years: they ranged from Gibbon's *Decline and Fall of the Roman Empire* to Hitler's *Mein Kampf*. Nowhere did I find the historical or philosophical solution, and it seemed indeed as if it was one of those problems which would defeat analysis until the end of time. But at this point I came across Buckle's *History of Civilization in England* and there read (vol. i, p. 6):

> Whoever is at all acquainted with what has been done during the last two centuries, must be aware that every generation demonstrates some events to be regular and predictable, which the preceding generation has declared to be irregular and unpredictable: so that the marked tendency of advancing civilization is to strengthen our belief in the universality of order, of method, and of law. This being the case, it follows that if any facts, or class of facts, have not yet been reduced to order, we, so far from pronouncing them to be irreducible, should rather be guided by our experience of the past, and should admit the probability that what we now call inexplicable will at some future time be explained. This expectation of discovering regularity in the midst of confusion is so familiar to scientific men, that among the most eminent of them it becomes an article of faith: and if the same expectation is not generally found among historians, it must be ascribed partly to their being of inferior ability to the investigators of nature, and partly to the

greater complexity of those social phenomena with which their studies are concerned.

That quotation led me to embark upon a study of civilization from the scientific angle—and this book is the result.

Since civilization is produced by men—and therefore by individuals—the question arose as to what conditions render it possible for a man to be at his best mentally and physically, for it seemed not illogical that where men enjoy conditions that permit them to be at their best there are present the raw essentials of civilization. The resultant inquiries into climatic, health, and energy factors have led to conclusions set out here, and these are then translated into terms of national assessments. This book does not pretend to have discovered all the causes of great civilizations, but it does, I hope, shed light on one cause—that of climate and man's growing control of it.

Naturally when a single thread is unravelled from the fabric of history it tends to attract more attention to itself than it should, but the reader will doubtless supply his own background of comparison and criticism.

I need hardly add that a work of this kind could not have been written without the skilled and always gladly given cooperation of archaeologists, scientists, and government officials, and I should like to pay particular tribute to Dr. T. Bedford of the Industrial Health Research Board, Professor J. L. Myres, New College, Oxford, Dr. (now Lt. Col.) Stanley Casson, New College, Oxford, Mr. Maurice Bennett, M.Sc., F.Inst.P., F.R.Met.S., Sir Paul Harvey, K.C.M.G., C.B., Mr. J. Macintyre, H.M. Office of Works, Sir Harold Hartley, and Mr. E. L. Hawke, M.A., F.R.A.S., Secretary of the Royal Meteorological Society. I should also like to record my warmest thanks to Mr. C. Tasker of the American Society of Heating and Ventilating Engineers, and to Professor Ellsworth Huntington of Yale University, for much excellent advice and for undertaking the arduous task of proofreading.

In the preparation of the American edition I was helped inadvertently by the War Office, which sent me on a tour of duty in the United States in mid 1943. Those months of residence in Virginia and New York were of the greatest value to me.

S. F. M.

April 1944

CLIMATE AND THE ENERGY OF NATIONS

I

THE CAUSES OF ENERGY

THERE are two subjects which are of perennial interest to all thinking men and women: the first is their own particular fitness and energy, and the second is the rise and fall of nations or peoples. Yet few writers have considered the interrelation of the one with the other, and still fewer have attempted to assess a factor that has profoundly affected both, namely climate and our means of controlling it or of sheltering from it.

We all know that, as individuals, although we may be fit and well, there are days when we feel lethargic and dull, other days when we suffer from nervous tension and are irritable. We know too that certain peoples, such as the English, are regarded as phlegmatic, whilst others, such as the Italians or the Greeks, are regarded as much more excitable.

Mankind has always been ready with hypotheses to explain mysteries, and on the personal side we find that the moon, or the liver, one's diet, or one's bank balance, may be made accountable for much, whilst on the national side the greatest savants and statesmen of all epochs have suspected the existence of natural laws that govern nations even as others govern men.

It may perhaps be well to consider for a moment a few of the theories that have been held, often for centuries at a time, to explain the greatness of a people. Everyone knows that the Jews based their claim to racial superiority on the possession of 'The Book,' and in early days, indeed, the religion of a people was thought to account for much of its greatness. On the other hand there have been purely material reasons. The people of Akkad, thousands of years ago, acclaimed the idea that since Europe, Asia, and Africa spread out around them, their central position automatically destined them to be the leaders of the world. Akkad and its civilization have passed utterly away, followed by a succession of nations, each of which believed in turn that there was some feature in its climate, situa-

tion, form of government, or religion that made it the perfect society and the chosen of God. Thucydides, through the mouth of Pericles, attributed the eminence of Athens to its free democratic form of government. Greece fell before Rome, whose greatness Polybius ascribed to the blend of monarchical, aristocratic, and democratic elements in its constitution.

Centuries passed, in which Goth and Ostrogoth, Arab and Moor, advanced from power to power, claiming greatness from mighty gods or the Prophet of Islam. Centuries later the Venetians, heirs of the West Roman Empire, believed that because Venice lay in 45° of latitude—exactly half-way between the Equator and the North Pole—she was destined to perpetual world leadership; and only a few years ago an eminent British scientist, Sir John Herschel, held that Britain's greatness was due to her position at the centre of the world's land mass.

Another school of thought, vigorously expressed by Thomas Carlyle in his *Heroes and Hero Worship,* finds in leadership the key to history:

> The history of what man has accomplished in this world is at bottom the history of the great men who have walked here. They were the leaders of men, these great ones; the modellers, patterns, and in a wide sense creators, of whatsoever the general mass of men contrive to do or to attain.

On the other hand, many historians believe that the situation naturally and inevitably produces the necessary leaders. If there had not been Napoleon to terminate the French Revolution by a military despotism, there would have been some other; if there had not been Lenin to create the Soviet Republics, someone else would have risen to do it. No one man, or even a dozen great men, ever produced a great civilization. The greatest upward movements in history were not the work of individuals, but of many. A Julius Cæsar must have his legions; a Shakespeare must have his audience; a Britain acquisitive of empire must have its navy, its soldiers, its administrators, and its merchants. It is true that every civilization has produced its great figures, but they are its finest flowers and not its seeds. The leading wave is but the result of tremendous forces pushing from behind and attracting from above.

Diet too has been advanced as a cause of national greatness, and the battle between various theories in this field has been

long and inconclusive. Opponents of the dietetic theory agree that a well-balanced diet is essential to human health, but assert that there is scarcely a country in the world to-day where a balanced diet is not obtainable at reasonable cost, and that there is as much malnutrition through ignorance in some of the industrial areas of Europe as among many African and Asiatic races that rank much lower in the scale of civilization. Ill-balanced diets are, in fact, common throughout the world. But authorities on deficiency diseases, such as Sir Robert McCarrison of the Indian Medical Service, are of the opinion that many native races of the East enjoy a perfectly balanced diet. Sir Robert, who worked for years as surgeon among the Hunzas of Northern India, writes:

> These people are unsurpassed in perfection of physique; they are long-lived, vigorous in youth and age, capable of great endurance and remarkably free from disease . . . They live on a high plateau, difficult of access; and they depend very largely on food of their own growing: grains, pulses, fruits and green vegetables.

Sir Robert attended large numbers of these people, but in nine years he never saw a case of gastric or duodenal ulcer, of rheumatism or pneumonia, of appendicitis or cancer. Yet even their greatest admirers could not assert that the Hunzas had produced even the elements of a civilization.

To many others, like Sir Raphael Cilento, 'The most outstanding fact in the world's history is disease and its distribution.' They aver that the rise or fall of civilizations coincides with the relative distribution of the two most vitiating and insidious diseases that afflict mankind—malaria and hookworm. Malaria, says Cilento,

> causes probably more invalidity than any other disease, while hookworm disease produces lethargy and dullness . . . Excluding areas with less than two persons per square mile, progress and civilization are seen to be singularly related to the distribution of disease. The whole problem of civilization in any region consists in the degree to which endemic disease can be controlled, modified by the ease with which the human organism can adapt itself to the situation.[1]

This suggests the question, why single out malaria and hookworm? Are not tuberculosis and cancer equally energy-destroy-

[1] R. W. Cilento, *The White Man in the Tropics*, pp. 67 et seq. See also below, Chapter x.

ing and depressing? And if in some way malaria and hookworm are worse than any other diseases, why did Egypt, Greece, Rome, China, and Spain, all malarial countries, each produce a great civilization while the non-malarial centres of North-West Europe and Northern America, though populated, remained ingloriously supine?[2]

Every part of the world has its diseases, and every fatal disease has its prelude of disablement, depression, and decay. One is irresistibly reminded that Horace found that all men could be wise save when they had a cold in the head.

Race too, as we know, has been and is held to be the prime source of national greatness, but here again there is much contention. As long ago as 1300 B.C. the Egyptians attempted to portray the various races of mankind, and in the temple of Seti the Great, at Abydos, four varieties are represented—Egyptians, Negroes, Syrians, and a fair-haired, blue-eyed people from Libya—a striking contrast.[3]

Among the first of the modern scientists to propound a theory on race was the German anthropologist Blumenbach, who in 1811, as the result of the study of a large number of skulls from the Caucasus, and a comparison of these with Negroid and Mongolian types, first described the inhabitants of Europe as 'Caucasian,' without distinguishing, as has since been done, between Mediterranean (long-headed brunets), Alpine (stockier and round-headed), and Nordic stocks (blue-eyed blonds).

Max Müller, however, writing seventy years later, approached the question from the standpoint of language, and employed the term 'Aryas' for those who spoke languages classified as Indo-European or Indo-Germanic.

> Aryas are those who speak Aryan languages, whatever their colour, whatever their blood . . . I mean neither blood nor bones, nor hair nor skull: I mean simply those who speak an Aryan language.

[2] It is also noteworthy that a recent Carnegie Commission Report (mentioned in Chapter XI) states that the evidence refutes the frequent assertion that malaria exerts a profoundly deleterious effect. 'Malaria does not, on the average, cause severe deterioration of physique or nutrition . . . This conclusion differs markedly from generally accepted views on the effects of malaria in the Transvaal.' See *The Poor White Problem in South Africa,* chap. iv, p. 116. See also Price, *White Settlers in the Tropics.*

[3] Sir G. Elliot Smith, *Human History.*

The same applies to Hindus, Greeks, Romans, Germans, Celts, and Slavs.[4]

Max Müller was contemporary with those who insisted that this 'race' alone, the Aryans, had been the creator and sustainer of all that is good and great in civilization. The chief exponent of this theory of race supremacy, before the Nazi rulers of Germany gave it a new importance, was Count Joseph Arthur de Gobineau (1816-82), a French diplomat and author; he gave the name 'Nordic' to those descendants of the original Aryans who had settled in Northern Europe. However much one may challenge this or any other racial theory, it will at least not be denied that the 'Nordics,' whatever their origin, have been and still are a vigorous people; but the Nordics were almost barbarians when Mediterranean culture was at its height, and most certainly were barbarians when Egypt flourished. Nevertheless the Nordic legend persists. We are told that the glory of Greece was due solely to invasion of Nordic tribes, and its decline to the assimilated Levantine strain; that Rome was great and powerful so long, and only so long, as she kept her 'Nordic' blood pure; that the rise of Spain and of Portugal was to be attributed to the blood of Northern Visigoths, and their decline to its dilution by Indian and Negro blood. We are told too that the Renaissance was a purely Nordic phenomenon, although Gobineau himself denounced it as the triumph of anti-Teutonic forces. But in all truth we must admit that we do not know what was the racial composition of peoples even a thousand years ago. The Spartans have been classed, not as Nordics, but as Alpines by Dixon, while of the Etruscans, blithely claimed by many as Nordics, Hertz, the author of *Race and Civilization,* says, 'Only one fact seems established beyond all doubt, that they were not Indo-Germans or Nordics.'

To add to the confusion of thought on these racial issues, historians agree that the racial composition of the British Isles has changed very little since the twelfth or thirteenth century, when it was a small and relatively insignificant island kingdom, yet by 1600 this same people had become a world power. Neither has the racial composition of Japan changed during

[4] *Lectures on the Science of Language.*

the last century—years which have seen her rise to heights undreamt of either by her forefathers or our own.

Recently, however, this philosophic theorizing as to the value of race has been supplemented by vigorous national action. In 1921, for instance, the United States, which hitherto was 'free to the world,' decided to limit severely the immigration of certain less favoured nationalities; in 1933 Nazi Germany, inspired by the same ideal, began its campaign of anti-Semitism; while at an even earlier date Australia decided to admit Anglo-Saxons only. The ideal behind all these policies is to build up a nation from the 'best' stocks, and in terms of modern nation-creating, as Germany, the United States, and Australia see it, the 'best' stocks are mainly north-west European, which in itself is almost indefinable.

Naturally the non-Nordic nations view this policy with mingled derision and alarm. As against the idea of Nordic superiority, the Latins proclaim that the Mediterranean gave birth to Western civilization, that Athens and Rome have been the teachers of the modern world, and that, if previously Egypt taught them, it is itself a Mediterranean country. Similar claims have been made, with equal force, to show the racial eminence of the Chinese, the Japanese, the Jews, and a score of other races.

In the welter of modern ideas about race, it is almost impossible to avoid the appearance of bias in one direction or another. Racial theories have become bound up with political theories; many authorities declare there is no such thing in the world as a pure race; anthropologists the world over are so divided in their views that there is common acceptance only of the broadest racial divisions. Certain it is that all human races can interbreed, that languages of one race can be acquired by another, that migration and intermingling in all directions have gone on for countless ages, and that to-day national groups often include several distinct racial groups.

The opponents of the racial theory assert that a brief survey of history shows conclusively that no race has a monopoly of civilized leadership. An astonishing variety of types have all in turn climbed to the apex.[5] In war, in trade, in science,

[5] So far as we are now aware, Negroes and Red Indians have never led the rest of the world. Yet the history of the Zulus or of the Iroquois shows that in

or in religious devotion, the sceptre of leadership appears to have passed from race to race almost without conscious effort on the part of the competitors. A generation ago the white world noted with trepidation the growing power and ingenuity of Japan, just as five hundred or a thousand years ago it dreaded the onrush of Turk or Moor.

To all these schools of thought there may be added the 'luck' school, which bases national advance on the discovery of some natural resource or some new method of agriculture, industry, or thought. For this school, the might of Great Britain, the United States, and Germany is based upon their iron and coal resources. Conversely, the restricted civilizations of Mexico, Peru, and Yucatan were due to their lack of horses, cattle, and iron; had they possessed these, John Lothrop Motley suggests, they might have equalled the Greeks. Certainly great natural resources may bring great prosperity, but has not Nigeria greater natural resources than Denmark, or Brazil than the Netherlands?

Again, there are those who assert that intense pressure of numbers at the heart of a nation has been associated with every great colonizing or conquering outburst—though great outbursts have not always followed increasing numbers. As a general rule, human beings will congregate where the natural resources and climatic conditions are most favourable. Here they will flourish and multiply until at last the area cannot hold the teeming numbers. Then the adventurous will seek out fresh territories, but in order to occupy them must often develop more courage or more cunning than the occupants they wish to displace. Alternatively they must either improve their agricultural economy, or submit to a lower standard of life coupled with increased susceptibility to disease, which in turn produces a balance between man and his habitat.

No race or nation appears to have a *natural* fertility higher than that of another. The large Victorian families of our grandfathers are paralleled by the unchecked human productivity to-day of Guatemala, Costa Rice, Palestine, or Russia, all

many characteristics, such as courage, they were, and perhaps still are, the equals of any race. Excepting the people of Liberia and Haiti alone, all the black races of the world acknowledge the political supremacy of the white man, and even these exceptions are perhaps due more to international jealousies than any great capacity or ability.

with an annual birth-rate of 30 to 40 per 1,000, and an annual excess of births over deaths of 15 to 25 per 1,000. At such rates the population of these four countries might double itself in fifty years. Obviously, if the land of these four countries has then to support double the population of to-day, either agricultural and industrial productivity must be increased, or new areas of settlement must be discovered: otherwise lack of nourishment will reduce resistance to disease, and the death-rate will increase. Nature in enabling man to breed so easily lays upon him the challenge to progress or die. Over-population may, indeed, cause a national decline through the reduced standard of living consequent upon unexpanding resources.

Luxury, social habits, caste, etc., have also been advanced as causes of national decline, but the history of any great civilization shows that every one of these ills can be cured if the vital energy is there. The history of Rome is a succession of changing governments, of great victories after great defeats, of pestilence and famine alternating with plenty, until suddenly her power seemed to crumble; she ceased to produce men equal to the occasion, her energy dwindled, and the grandeur that was Rome ceased to be. If luxury was the reason, surely she could have rekindled her flame after the pillage by Genseric in 455. If malaria was the cause, why did not her decline occur at any time during the preceding thousand years? If the 'Baltic herring and Egyptian wheat' resulted in the decay of Roman agriculture and the annihilation of a sturdy peasant class, why was it that Rome could not, and did not, produce men capable of wise constructive measures?

Broadly speaking, national success has been variously attributed to religion, climate, race, pressure of population, diet, laws, language, the emergence of great men, trade routes, and so forth, and national decline to luxury, disease, social habits, caste, and the like.

It is not my purpose to investigate in detail these various opinions, but rather to ascertain if, in addition perhaps to these many causes, there is not a common factor which may also help to make a nation great and to give it cultural, economic, or political leadership of the world. This work seeks to determine whether or not climate and climatic controls influence civilization.

II

CLIMATE AS A FACTOR

THE idea that climate is an important factor in the history of civilization is by no means a new one, for two thousand years ago Aristotle, Hippocrates, and Herodotus thought that the rise of Greece and the fall of the mighty empires of Asia Minor confirmed the excellence of the climate of Greece. Aristotle expressed the opinion that the colder countries of Europe had inhabitants full of spirit, but lacking in intelligence and skill; the Orient reared men gifted with intelligence and invention, but born to be slaves; but the Greek was high-spirited, intelligent, and a lover of freedom. Herodotus wrote of his own country, the western shore land of Asia Minor, and the Ionians who lived there:

> They set their cities in places more favoured by skies and seasons than any country known to us. For neither to the north of them, nor to the south, neither to the east nor to the west, does the land do for its people what Ionia does; for in one region it is afflicted with cold and wet, and in another by heat and drought: . . . it would seem that Hellas has the seasons tempered by far to the kindliest.

Not unnaturally such ideas were not expressed by Greek writers after Greece had been invaded by Rome, and still less were they mentioned when the whole of that part of Europe was overrun by the Turks.

But of late this theory of the importance of climate has been raised again by biologists, historians, and climatologists. The biologists assert that since for all other forms of life, whether plant or animal, there are certain conditions which produce the finest stocks, so for man there must be certain combinations of diet and climate which produce the most efficient and most energetic human beings. But since it is obvious that the leadership of civilization has moved from centre to centre in the last five or six thousand years, some climatologists assert that

there must have been climatic fluctuations of no mean degree and that in accordance with these fluctuations the focal points of civilization are continually, if imperceptibly, changing. Eminent American professors, such as Ellsworth Huntington, stress this importance of climate. He asserts that Greece attained her glory at a time when her climate was probably as stimulating as that of Chicago to-day. He thinks that this was due to greater storminess in the past than at present, thus making the climate more favourable to crops and more stimulating to human health and activity, although without much change from the present conditions of temperature.

No exponent of this theory of climatic change has attained greater popularity, or suffered more criticism, than Ellsworth Huntington, who states plainly that a great part of his work stands or falls by a theory of climatic pulsation in historic times. The following summary condensed from his *Civilization and Climate* will give an idea of the argument:

> Suppose that from 500 to 400 B.C. Athens had (1) somewhat cooler summers and warmer winters than now, with a mean annual temperature of 62° instead of 63.2°; (2) a relative humidity at all seasons 10 per cent. higher than now; (3) an annual rainfall of 22 inches instead of 15 inches; (4) number of storms twice as great as now. 'When we calculate the effect of such changes upon health in the same way that we have calculated the data for our map of climatic energy based on the effect of the seasons in American cities, the result is astonishing . . . Athens rises to a level practically the same as that of New York or Chicago, and enterprise, physical vigour, and mental activity result.'

But even with these changes, I do not think Athens would become comparable with Chicago. As Huntington himself points out, there has been apparently little change if any in the temperature and vegetation of the area, and the olive and the vine still flourish in their ancient settings. In my opinion, before Athens could become comparable with Chicago there would need to be a temperature change of 13° or 14°, for where Athens has an annual mean temperature of 63.2° F., Chicago has an annual mean of 50° F., and is thus on the average 13° or 14° cooler than Athens.[1] Athens is in fact over twenty degrees warmer than Chicago in January, 49° compared with 26°.

[1] See E. G. Mariolopoulos, *Étude sur le climat de la Grèce* (Paris, 1925), for a refutation of Huntington's theory.

There are of course other climatic factors besides temperature which sharply distinguish the climates of the two areas.

But even if there were changes, surely these would have spread to neighbouring areas, such as Turkey, which, instead of remaining obstinately somnolent as Crete did for two thousand years, surged westwards and shook Europe to the gates of Vienna.

Great climatic changes have undoubtedly taken place in the course of the world's history, but these have been so slow that to hold them responsible for great national upsurges in modern times is to lay too much to Nature's account. The base of these theories is that the radiation from the sun varies from epoch to epoch, and that in accordance with these changes the polar ice caps advance or recede.

Dr. C. E. P. Brooks, Dr. Ernest Antevs, and others have pointed out, and appear to have proved conclusively, that the polar ice caps are still retreating at the rate of about 500 feet per year, with oscillations; that the oceans are steadily rising at the rate of a fraction of an inch per century owing to the melting of the ice at the poles; and that the temperature of the world is gradually rising, owing to the return of 'genial' conditions of the world as a whole and to the gradual decline in the refrigerating effects of the great polar ice caps.

One of the outstanding illustrations of this theory is that the ice-front in Glacier Bay, Alaska, has retreated about sixty miles in about one hundred and forty years, i.e. from the time of Captain George Vancouver's first survey in 1794 to the latest report of the District Engineer of Victoria, B.C. Possibly there has been quite a warming up of the climate in this area, but if we take the meteorological records over the same period (1770-1936)[2] for those cities in Europe for which such records are available, we find little evidence of a general warming up. In Vienna, temperatures have declined by about 1° F., whilst in Vilna and Berlin, on the contrary, they have risen by about 1° F. Now it is obviously impossible to conclude that Vienna has been getting progressively cooler over the centuries, if Berlin and Vilna have been getting warmer. In North America, according to J. B. Kincer, there seems to have been a slight

[2] Given in *World Weather Records*, published by the Smithsonian Institution of Washington. See also Prof. D. Brunt, *Geographical Journal*, March 1937.

warming up on the Atlantic seaboard over the last century, but on the other hand Bermuda would appear to have become a little cooler since 1866. The only conclusion that can be drawn is that from year to year, and from decade to decade, climate fluctuates in every centre, and that whilst areas near the poles may be warming up, owing to recession of the polar ice caps, there is little evidence of any comparable rise of temperature nearer the tropics.

Evidence from other sources confirms this view. Archæologists and phenologists are united in thinking that there is little or no proof of any dramatic change in *temperature* during the past two thousand years in Greece or Italy, though there is very definite proof that the lands of Babylonia, Persia, Egypt, and even India, at the height of their long period of glory, were *moister* than to-day. For the moment we are content to record the statement of Sir Ernest Wallis Budge and other Egyptologists of the British Museum that

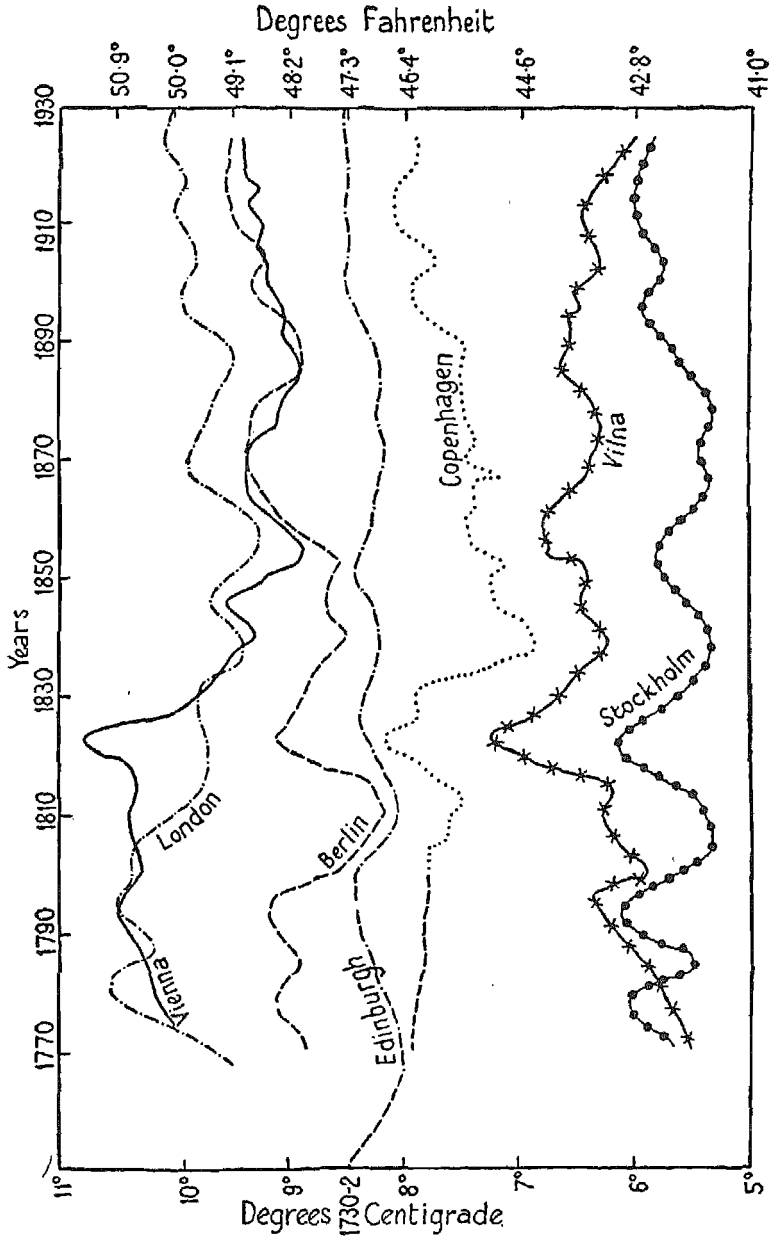
> although certainly less dry than now, the climate [of Egypt] cannot have differed very greatly from that of the present day . . . In earlier days, no doubt, this was not so: then the rainfall was constant, and the desert wadis with their water-worn rocks and pebbles were formed, which, though now they have been dry for millennia, still preserve the appearance of dry watercourses . . . The Nile valley was in palæolithic days simply a swamp.[3]

Similarly in India, Sir John Marshall, Dr. J. H. Hutton, and others point out that

> Everywhere in southern Baluchistan there are remains of enormous dams and *bands,* proving that at one time the land was elaborately irrigated and pointing perhaps to the period at which its natural waters began to fail on account of climatic changes involving the undertaking of conservancy on a larger scale, and we are probably justified in picturing Baluchistan, a land of hills and valleys indeed, but now barren and windswept, as five thousand years ago (period of the Mohenjodaro civilization) a good land of fountains and depths, drinking water of the rain of Heaven.[4]

Again, all authorities agree that thousands of years ago the Persian Gulf extended a full 250 miles farther north, even if only a tidal swamp for its northernmost reach, that the oasis

[3] *Guide to the Egyptian Collections* (The British Museum, 1930), p. 274.
[4] *Census of India,* 1931, vol. i, p. 454.



THE FLUCTUATIONS IN TEMPERATURES OF EUROPEAN CITIES FOR WHICH RECORDS GO BACK OVER 150 YEARS.

THE LINES HAVE BEEN SMOOTHED OUT OVER TWENTY-YEAR PERIODS; THUS THE TEMPERATURE SHOWN FOR THE YEAR 1850 IS THE AVERAGE OF TEMPERATURES FOR 1840-59.

of Kharga in the Egyptian desert was an extensive lake, and that the Caspian Sea was much larger than to-day.[5] Thus the whole of this area, from Persia to Egypt and from Arabia to the Caucasus, while it may not have been much cooler thousands of years ago than to-day, certainly had a heavier rainfall. Mesopotamia may also have had a less extreme range of temperature owing to the greater water expanse of the period.

This recession of the waters is a fact of prime importance in considering the history of Babylon and indeed that of the whole region from Egypt to Persia. Ancient cities such as Larsa, Susa, Al Ubaid, Ur, and Eridu, now from 150 to 200 miles inland, would then have been, if not on the sea-coast, at least within easy reach of the sea.

This region, therefore, must have presented at that period of the world's history a well-watered, fertile plain with a less extreme but more rainy climate than to-day; and all the investigations that have been carried out by archæologists seem to bear out this conclusion. Sir Leonard Woolley, for instance, records that the temperature at Ur nowadays rises from below freezing-point in winter to a summer maximum of 137° F. in the shade, and that dust storms are so dense that the sun sometimes cannot be seen for six weeks on end.

Had this always been the case, Ur could never have been a great city: that it was great is proof that the conditions of the climate were not then the same. To-day the difference of temperature between Ur and Nasiriyah, only eleven miles away, may be of 10° or more, and that is because round Nasiriyah there is a cultivated belt, and the Euphrates flows beside it (as it formerly flowed by Ur) and there are not great expanses of sand to reflect heat. When all was fertile, the soil being irrigated by innumerable channels, there were no such extremes of heat and cold as there now are.

Woolley goes on to say that in 2000 B.C. the population of Ur would be about 500,000, for it consisted of four square miles of closely packed houses.[6] To-day the city of Basra has a population of only 85,000.

[5] Herodotus (485 B.C.) describes the Caspian as being then six times longer than its breadth. From this, Huntington infers that the Caspian was then 185 feet higher than its present level, and united with the Sea of Aral. See Brooks, *Climate through the Ages*, p. 361. The Caspian level has been dropping sharply since 1913, and the Soviet Government in 1945 set up a special Caspian Commission to study this problem.

[6] C. L. Woolley, *Excavations at Ur*, pp. 2 et seq.

It is of course possible that the changes postulated by Woolley, Hutton, Marshall, and others may have been due not to climatic changes but to man's destruction of forests or misuse of the soil. The history of the human struggle over nature is fundamentally a struggle against vegetation as well as for it, and man's success against forest or scrub is often his own undoing. Hugh C. Bennett and W. C. Lowdermild, writing in *Soils and Men,* the official Yearbook of the U. S. Department of Agriculture for 1938, make this point with some emphasis.

> Too frequently [they say (p. 582)] man's conquest of the land has been disastrous; over extensive areas his culture of the earth has resulted in extreme impoverishment or complete destruction of the soil resource on which he is dependent. So direct indeed is the relationship between soil erosion, the productivity of the land and the prosperity of a people, that the history of mankind, to a considerable degree at least, may be interpreted in terms of the soil, and what has happened to it as the result of human use.
>
> Recent archeological studies suggest that the hand of man, rather than climatic change, caused once rich and populous regions to be reduced to poverty or complete abandonment. Abuse or neglect of the land that sustained their populace and their commerce is believed to have played a major part in the decline of civilizations now extinct.

J. A. Ainslie of Nigeria, South Africa, has the following to say about the French Niger Colony: [7]

> A few months ago I had the opportunity of visiting the French Niger Colony lying to the North of the Nigerian boundary: that country is very largely desert and includes within its area probably the most dreaded desert region in the world; nevertheless, throughout the country there are many ruins of ancient towns and villages; it was evidently at one time heavily populated, and so must have been a well-watered region. There are both Arab and French records to show that up to the middle and towards the end of the eighteenth century these towns were inhabited by an active farming and trading people; the area, however, became deforested and it has only taken some 200 years to depopulate a country as large as the Union of South Africa . . . First came the shifting cultivator with his axe and fire; secondly, the grazier with his camels, cattle, sheep and goats . . . and now comes the desert . . .

Other archæologists and geographers believe that portions of the Sahara, and central Asian deserts, and parts of Palestine,

[7] *Desiccation in West Central Africa,* 1935.

Mesopotamia, and the Gobi once teemed with human life.[8] Marsh estimates that 500 towns once flourished in what are now the dry depopulated plains of Asia Minor.[9] Tepe Mawra, whose ruins were recently discovered in northern Mesopotamia, is thought to be the oldest town in the world of which remains still exist, for it was a well-planned city about 3700 B.C. and must have represented long ages of prior development.[10] The capital of the rich kingdom of the Queen of Sheba is believed to have been found under shifting sands.[11] Parts of the west coast of South America, where the oldest known civilization in the Western Hemisphere existed, now are treeless and barren.

> The very fact that regions scarcely habitable to-day once supported rich cultures is evidence itself of the decline of the land. Climatic changes, to which this is often attributed, have occurred in the geologic past and are doubtless still in progress; but they usually take place far too slowly to affect human institutions or history in any immediate sense. The progressive deterioration of the land resulting from abuse or neglect seems certainly to have contributed to the crumbling of ancient civilizations.[12]

In a later chapter we shall see how this same problem is affecting the United States to-day, and how, not only in the 'Dust Bowl,' but over a very large part of the United States, erosion and land abuse are helping to destroy the culture of entire regions; we shall also see that the destruction of forests can change the climate of the immediate area by several degrees of temperature and several per cent of relative humidity, and make still greater changes in the immediate soil conditions.

For the moment it is sufficient to state that in eastern Tennessee, where a 7,000 acre area was completely stripped of forest by copper smelter fumes, the average temperatures of the stripped area increased from 3° to 4° F., wind velocity increased many times over, evaporation more than doubled, and precipitation declined by 20 per cent. These represent considerable changes, and it is an additional significant factor that since the denudation of forests there has been a gradual

[8] See Huntington, *The Pulse of Asia;* 'Man-made Deserts' in *Pacific Affairs,* 1935, 8, pp. 409-19; and Sir Aurel Stein's *Ancient Khotan,* 1907.
[9] George Perkins Marsh, *Earth as Modified by Human Action.*
[10] E. N. Fallaize, 'The East,' in *Sci. Prog.,* 1933, v. 28, pp. 137-40.
[11] J. H. Breasted, *The Conquest of Civilization,* 1926.
[12] *Soils and Men,* p. 583.

rise in average temperatures of about 2° in all the eastern areas of the United States since about 1875.[13]

It is an intriguing thought that if only all goats, camels, and men could be deported from North Africa, Mesopotamia, north-west India, and the Dust Bowl, the land might revert to its natural fertile state—but instead of being diverted further let us return to our main theme.

Much attention has been paid, in respect to climatic influences, to the ancient Indian civilization at Mohenjodaro, and Mrs. D. Mackay says:

> From the evidence of the seals found in the ancient city of Mohenjodaro it seems certain that the climate of the Indus Valley was far moister five thousand years ago than it is to-day. On their seals the craftsmen of Mohenjodaro portrayed with the faithfulness of familiarity those denizens of moist, lush jungle—the elephant, tiger, and rhinoceros—which are no longer known in Sind. The lion, a lover of dry open country, has not yet been found on seal, amulet, or painted pottery. He was evidently almost unknown, though to-day he roams the hills of Kathiawar, not far south of Sind. Moreover, it must have taken immense quantities of wood to burn the bricks required in the construction of a city so large as that which excavation has revealed at Mohenjodaro—a fact which argues a more thickly wooded condition of the Sind country than that which exists at present.[14]

Other evidence in this direction has been most carefully considered and sifted by Dr. C. E. P. Brooks in his *Climate through the Ages,* who, in addition to supporting the theory of climatic changes in Northern Africa and Western Asia, gives a 'generalized temperature curve' for Europe showing that from 250 B.C. to A.D. 250 the climate was 'cool'; from A.D. 250 to about A.D. 900 'comparatively warm,' and from A.D. 900 to the present day, fluctuating between these two extremes, but generally below the average.[15]

Thus during the last 40,000 years it may be agreed that there has been a warming up of the climate of the north temperate regions (and, by inference, of the south temperate re-

[13] See Raphael Zon, 'Climate and the Nation's Forests,' in *Climate and Man,* a symposium published under the authority of the U. S. Dept. of Agriculture, p. 486.

[14] *Geographical Magazine,* August 1935.

[15] Professor J. B. S. Haldane, in his *Keeping Cool,* pp. 2 and 196, says 'From 1800 B.C. to 450 A.D. the weather [in N.W. Europe] was much wetter than at present, and between 450 and 1000 A.D. much warmer and drier than it is now.'

gions), but that this warming up, if it were steady, would not amount to more than 1° F. per 1,000 years.

Now a steady rise in the temperature of these regions of not more than 1° F. per 1,000 years would not have resulted in serious changes in the temperature of any of those areas in which civilization has flourished.

Rome and Athens were at their zenith about two thousand years ago, Egypt and Babylon about four thousand years ago; therefore, if we suspect a maximum increase of 1° per 1,000 years, we cannot attribute to them in those times temperatures approaching those of Chicago, or New York, at the present day.

Thus, whilst there may be reason to think that the climate of Egypt, Babylon, India, etc., may have been anything up to 5° cooler three or four thousand years ago, there is little reason to suspect a drop of about 15°, which is required to bring it to the present levels of London or Chicago. The whole weight of scientific investigation, whether astronomical, archæological, or phenological, is against such a supposition. There is, however, much ground for supposing that most of these areas were moister then than to-day, and whilst this might explain their greater prosperity in those times, it would not account for the transfer of world-leadership from those regions to north-west Europe and northern America during the last five centuries.

We must, indeed, look deeper for the causes of the growth of civilization, avoiding bias either in favour of a particular nation, race, or religion. After a full consideration, I am convinced that one of the basic reasons for the rise of a nation in modern times is its control over climatic conditions: that the nation which has led the world, leads the world, and will lead the world, is that nation which lives in a climate, indoor and outdoor, nearest to the ideal, provided always that its numbers are large enough to resist invasion by its rivals. Civilization to a great degree depends upon climate control in a good natural climate.[16]

[16] It is worth noting in passing that an American writer, S. C. Gilfillan, put forth the idea in the *Political Science Quarterly* (1920) that progress was moving 'coldward,' since each succeeding civilization had an appropriate cooler temperature in which it flourished due to man's development of clothing and heating methods, so that by A.D. 2100 Montreal, Memel, and Oslo would be the focal points of civilization. He advanced the opinion that 'the whole of the Southern Hemisphere was hopeless from the point of view of leadership in civilization,' and concluded with the dramatic phrase, 'on towards the Pole Star the Ship of Destiny Sails.'

III

HUMAN REACTIONS

Of all the factors that may assist or retard the development of a nation the most permanent, if it is a factor, is climate. Great men come and go, and their wisdom is often undone by successors less noble; laws are rescinded; races intermarry with other races; economic resources vary in importance with changing needs; but climate, fickle and changeable as it is, is still the most stable, the most consistent, and in many ways one of the least controllable of all external effects that influence men.

Every second of the day the environmental factors of temperature, humidity, air movement, and radiation are having their effect upon our bodies and our energies, and there is not the slightest doubt that the ideal combination of these factors goes a long way towards enabling men to be healthier and more energetic.

We have, therefore, first to consider whether there is an ideal climate in which man will thrive better than in others. We all know that men die from sunstroke, or from being frozen, and one obvious condition of the ideal climate is that it must neither kill nor incapacitate a man. Since freezing-point is 32° F. and sunstroke-point near 100° F. it might be assumed that the ideal is about midway between these two extremes—i.e. about 66° F. But whilst this is the right answer, or very near, we have to prove that this is so.

One of the conditions of health and energy is the maintenance of a constant body temperature, and in man the average mouth temperature should be about 98.4° F., and the temperature of the deep tissues about 99° F. In health these temperatures vary but slightly. The body temperature is controlled by physiological mechanisms which regulate both the heat production within the body and the rate of loss of heat from its surface.

Human beings lose heat (1) by radiation to surrounding sur-

faces, (2) by conduction to the surrounding air, and (3) by evaporation through insensible perspiration and by sweating. Insensible perspiration occurs even in a cold environment and increases in warm surroundings. Sweating is due to the sweat glands of the skin, and may be regarded as an emergency mechanism which operates when the loss of heat by other methods is insufficient.

The rate or mode of loss of heat from the body is, of course, greatly influenced by radiation, by the temperature, velocity, and humidity of the air, and by the activity of the individual. These factors are naturally rarely the same for any length of time, and their ceaseless variation relieves us from monotony and drowsiness and stimulates tone and metabolism.

The calm serenity of the Elysian fields may be ideal for the gods, but for mere mortals, alternations of excitement and tranquillity, both mental and physical, in their due proportions, bring us near to the classic ideal of *mens sana in corpore sano*. But the changes must not be too great. Man may be the highest product of the animal kingdom, the most intelligent and the most adaptable, a superb triumph of evolution, but his control of body temperature is feeble compared with that of many animals. The bat can survive a change in its own body temperature of 60° F. or more, while most animals possess some form of temperature control, from the adjustable feathers of birds to the honeycomb of the elephant's ear serving as an air-cooled radiator for the blood. Many animals can suffer a change of ten degrees in their body temperature without inconvenience, but man must keep his body's temperature near 98.4° F. or suffer accordingly.

How are we to assess our climatic environment and its effects? It must be admitted at once that there is no instrument universally accepted which will give us an accurate idea of the comfort factors in the atmosphere. The Kata thermometer, the eupatheoscope, and other instruments, which are decidedly better than the dry bulb thermometer in this respect, are limited in their application, and for the purpose of this work we must have some measure of climatic conditions that meets with general acceptance. The thermometer, whilst an inferior instrument for measuring environmental conditions that are healthy and comfortable, since it merely indicates the tempera-

ture of the air in its immediate vicinity and ignores numerous other factors, has won such acceptance. Moreover, there are available for every large city of the world day-by-day thermometer readings which in some cases go back for two centuries, thus affording an historical as well as a current method of ascertaining climates.

But environmental warmth, which the thermometer indicates, is only one of the atmospheric factors affecting human comfort and energy. Humidity, air movement, and radiation all play their part, while still unknown factors, such as the electric content of the air, may have more to do with human energy than we yet imagine.

The combination of heat and humidity, in particular, is one which the human body cannot gladly endure, and humanity has devised little protection against such conditions. Since moist heat at 80° F. may cause sunstroke, while a dry heat of 100° F. can be safely endured, it is important that we should know the degree of moisture in the air. Humidity can be tested by a comparison of the dry and wet bulb thermometer, or by hygrometers, and in this respect figures for relative humidity (i.e. the percentage of saturation) are obtainable for every large city of the world.[1]

Like temperature, the relative humidity of the atmosphere changes every hour, but in spite of fluctuations it is almost as steady as temperature. We therefore accept it as the second most important factor in the climate, with air movement as the third.

In considering outdoor climates we must further add the important factor of radiation, i.e. the direct effect of the sun.

I have attached much less importance to air movement and

[1] The wet bulb thermometer is perhaps a better indicator of atmospheric conditions from the point of view of energy and comfort, and some authorities have placed full reliance on this instrument. It may be asked why we should not take, as do Griffith Taylor, Haldane, and others, the wet bulb thermometer alone, or alternately, the water-vapour content. The wet bulb thermometer alone still exaggerates the effect of temperature and makes no allowance for oppression induced by high humidity; while the water-vapour content figures are difficult to ascertain for comparison. Both the wet and dry bulb thermometers indicate the effect of temperature on themselves; they do not show the cooling and evaporating power of the environment on the skin and the respiratory membranes. They are static instruments, while the body is dynamic, producing heat which must be lost at an equal rate to keep the body temperature normal. See *The Kata Thermometer and Efficiency* by Sir Leonard Hill, which should be read in connection with this chapter.

radiation than to temperature and relative humidity for this reason, that although we cannot and do not evade unpleasant air movements or excessive radiation completely, we can and do evade them more easily than high temperatures or high humidity. In bad weather we can avoid wind by getting into buildings or vehicles. A gale becomes still air indoors, but humidity persists indoors and outdoors except during the winter months, when doors and windows have been closed and heating apparatus brought into play. Moreover, the effects of varying climates will be difficult enough to estimate on temperature and relative humidity readings alone, and air movement and radiation would complicate the issue so much that for clarity's sake they must be omitted.[2]

The meteorological offices of England and other countries have for approximately a century, in many cases, recorded weather conditions in their respective areas, but nearly always in terms of the dry bulb thermometer, relative humidity, hours of sunshine, and air movement. So, for want of any better standards that can be applied to the whole world, we are compelled to rely on these readings, whilst endeavouring to interpret them in terms of cooling power, radiant energy, and drying power.

The ideal atmosphere is that which permits the waste heat of the body to be dissipated as soon as developed, neither too fast nor too slowly, in order that the body's temperature may be maintained at the required 98.4° F. Dry air mitigates heat by accelerating evaporation from the skin, but very dry air produces in the human being excessive nervous excitability and sleeplessness.[3] Moist climates have the opposite effect of producing nervous depression and lethargy. Now, whilst the complicated human mechanism of heat elimination will adjust itself to a considerable range of external temperature or moisture, it adjusts itself at the expense of energy and efficiency.

[2] Unless otherwise stated, it is assumed that all climatic factors are associated with unspecified air movements varying as do the air movements of the British Isles, and the climatic factors are not corrected for air movement except in such cases as the calms of India or the gales of Patagonia, where air movement is an important vital fact in our inquiry.

[3] Ruttledge on his Everest expedition noted that the altitude and dryness made it impossible to sleep, and caused agony in teeth and intense irritability. The party degenerated rapidly, becoming less energetic and losing appetite and weight. (See *Everest*, 1933, pp. 262-3.)

Is there then an 'optimum' climate for man irrespective of his race, origin, or traditional environment?

It can be said at once that there is no specific optimum, but that there is an optimum range, and the optimum range covers temperatures, humidities, and so forth, suitable for man in all that great variety of states from profound slumber to extreme physical exertion. It is, perhaps, easier to obtain the slumber optimum than the optimum for any other state, since environmental sleeping factors all over the world vary much less than environmental action factors. No matter in what part of the world a man may be, with the possible exception of the equatorial heat belt, he demands, as his ideal sleeping conditions, darkness and a temperature somewhere between 75° F. and 80° F.[4]

If the local temperature is lower than this, he will seek, by means of heating apparatus, bedclothes, or even by huddling himself up, to raise the temperature, within a few millimetres of the skin, to this level, and if the head is exposed to a colder atmosphere a higher environmental body temperature will be required in compensation. Thus it may be said that the ideal atmospheric condition for man, when at absolute rest, is a temperature approximately 75° F. to 80° F., with lightly moving air.

But it is when the man that we have in mind wakes up that the number of variables affecting his environmental atmosphere increases. First, there is the increased pace at which the body itself works, the faster pulse, the effects of meals, with the consequent improvement of bodily heat production; then the effect of movement in another form, that is of increasing the pace of the air-flow round the body, the effect of radiation whether it be from a fire or from sunshine, the effect of varying humidities, from the high moisture content of a bathroom to the drier atmosphere of an ordinary sitting-room or office. All these changes can occur indoors, but the moment the man goes out of doors all these factors are complicated by still greater air movement, which may vary from a slight breeze

[4] See J. Mactinyre in the *Journal of the Institution of Heating and Ventilating Engineers*, February 1937. This temperature is the temperature in the immediate vicinity of the skin, and in cold climates therefore would be the temperature under the bedclothes and not in the room.

to a violent gust; by radiation, which may differ greatly as a lightly clothed body passes from shade to sunshine; and by other factors such as the effect of rain on the face or limbs, or the electric content of the air, about which we know even less than about temperature and humidity.

It is interesting to note at what temperature and humidity feelings of oppressiveness, laziness, or lethargy first become apparent. In this respect some very careful work was done years ago by M. Lancaster of the Belgian Meteorological Service, who as the result of many experiments came to the conclusion that there was an oppression curve beginning at 70° or lower, when the relative humidity is 80 per cent or over, and extending to 82° with the low humidity of 44 per cent. But the most authoritative survey is that given by Professor D. Brunt in the *Meteorological Journal* for April 1943, in which he charts the exact conditions under which the first physiological reactions to heat and humidity are observable. My own experience, which includes many months of residence in India, Africa, and the Dutch East Indies, shows that whenever the thermometer rises over 80° and humidity exceeds 80 per cent, the feeling of oppression is accompanied by distinct laziness, but the oppressive feeling is very much modified if there is a breeze of 20 m.p.h. or more. Thus a ride in an open car at 85° and 80 per cent relative humidity (average conditions in the Dutch East Indies) is quite pleasant, but the moment the motion through the air ceases the feeling of oppression becomes quite perceptible. At 90° or over, wind seems to make no difference, and I have never found 90° pleasant under any conditions, whether humidity be low or not.

On the other hand, a feeling of chilliness arises when any part of the body is exposed to temperatures of less than 50° F., unless the body is in active movement, and with lower temperatures chilliness gives place to shivering and great discomfort.

Thus it may be said as a broad rule that all temperatures over, say, 80° F. and all below 50° are distinctly unpleasant to an exposed body, and that one's energy and health suffer in some way if these conditions have to be endured for any length of time.

I turn with relief from rough approximations of this kind

to consider the many scientific investigations and tests that have been made, notably in England and the United States, to ascertain what are the 'best' climatic conditions. Not unnaturally these investigations have mainly been concerned with factory or office conditions.

It must be remembered that there are four distinct cooling rates for the human body:

(1) The cooling rate associated with a dry naked body, as, for example, when sun-bathing.
(2) The cooling rate of a wet naked body, as, for example, after a swim or a bath.
(3) The cooling rate of a body dryly clothed, which rate in turn varies with the weight, texture, and cut of the clothing. Close-fitting woollen underwear, for example, will conserve heat in a much more effective manner than the toga of antiquity with its loose, rippling folds hanging from the shoulders, or the Greek chiton.
(4) The cooling rate of a body clothed in wet clothes.

Of these all but the third may be regarded as abnormal conditions in civilized countries—that is to say, that whilst one may frequently sun-bathe, or swim, or get wet through, it is much more usual to be dryly clad, and therefore it is this condition we shall have in mind in the succeeding pages.

All investigators are agreed that extremes of heat or cold, of humidity or dryness, of air movement or stillness, militate against the full exercise by the human animal of his powers and abilities, but there is still some divergence of opinion as to the precise happy medium in respect of all these conditions.

We must therefore consider briefly the conclusions of the two main investigations, the one British and the other American. On the British side there have been a series of inquiries under the ægis of the Department of Scientific and Industrial Research headed by Dr. H. M. Vernon and Dr. T. Bedford. The former, in his *Principles of Heating and Ventilation,* states that the ideal temperature with a slight air movement (i.e. 50 feet per minute or less) is 66.1° F. in summer and 62.1° F. in winter, and this estimate is supplemented by Dr. T. Bedford, who, in his *The Warmth Factor,* gives 64.7° F. as the ideal indoor winter temperature. On the other hand, the principal American investigations conducted by the Research Lab-

oratory then at the U. S. Bureau of Mines at Pittsburgh (F. C. Houghten, C. P. Yaglou, and others) led to the conclusion that, in still air, at 50 per cent relative humidity, the ideal indoor temperature is 75.7° F. in summer and 70° F. in winter.[5] Other investigators, including German, give ideals between the British and American optima quoted above.

All observers agree:

(*a*) that lower temperatures are required with increasing humidity—broadly speaking, the ideal temperature is reduced by one degree for every increase of 6 per cent in the relative humidity;
(*b*) that in still air temperatures over 76° are uncomfortable save only at low humidities;
(*c*) that with a relative humidity of over 80 per cent, temperatures over 70° in still air are uncomfortable;
(*d*) that temperatures below 60° are uncomfortable for sedentary or light work, except for children, for whom temperatures of 58° to 60° have been recommended by some investigators;
(*e*) that no single index of comfort exists, i.e. that acclimatization over a short or long period renders temperatures slightly above or below the ideal agreeable, and that age or youth plays its part in individual reactions.

But whilst there is therefore much agreement there is an apparent divergence of several degrees between the American and the English ideals of temperature. The question is, would Dr. Vernon's Englishman, working happily at 62.1° F., feel comfortable and energetic in Pittsburgh at 70.0° F.? The problem is one that has exercised the minds of both sets of investigators for several years, and great efforts have been made to explain this difference. The conclusion is that the American is most efficient in a temperature a few degrees higher than the Englishman because:

(1) The American summer being drier and hotter than the English summer, and American houses, factories, etc., through different heating methods, being warmer in winter than the English, the American worker is accustomed to higher temperatures and greater dryness.

[5] These figures may be compared with Bedford's 'comfort zone,' which ranges from 55.8° to 73.7°, and Yaglou and Drinker's 'comfort zone,' which ranges from 66° to 75° in the American summer and from 63° to 71° in the American winter. See Bedford, *The Warmth Factor*, p. 34, and the *Transactions of the Institution of Heating and Ventilating Engineers*, vol. 35 (1929). The German ideal, given in the symposium *Klima, Wetter, Mensch* (Leipzig, Quelle & Meyer, 1938), is 69.5° F. with 50 per cent relative humidity.

(2) Americans wear fewer or lighter clothes than Englishmen. The 'weights' of underclothing popular in the two countries reveal an interesting difference, while the Englishman's reluctance to leave off a waistcoat, or, in the case of office workers, to work in shirt-sleeves in hot weather also has a bearing on the matter.

If due allowance is made for these factors, it will be seen that the difference between the American and English ideals approaches vanishing-point, and is at most of only one or two degrees.

Since the difference is so small when compared with weather variations, I propose to accept the whole range of temperatures from 60° F. to 76° F. as constituting an ideal zone, with relative humidities at noon varying from 40 per cent to 70 per cent. In other words, any local 'ideal,' whether it be that of Pittsburgh or of London, is accepted as part of a world ideal.

This wide range of temperatures permits a still greater difference of clothing. If the American, in his light cotton underwear and no coat, prefers an average temperature of about 73°, it follows that the Indian in his loin-cloth, or the industrial worker stripped to the waist, may prefer to go up to 76°, but the cooling effect of moving air on the naked body should not be overlooked here; while the Scandinavians or the Scots, with still heavier clothing than the English, may prefer a temperature lower than the English average of 65°.

The question naturally arises whether these figures take into sufficient account the question of acclimatization. It is beyond question that the Negro races with their darker pigmentation and thicker skulls are better able to resist the heat of the tropics, but as Stefansson says:

> It is doubtful whether there has been any biological adaption of man to his northward movement from the tropics or sub-tropics; at any rate, it seems clear that the Eskimos, most northerly people in the New World, get their faces frozen as easily, shiver as often, and make all similar responses to chill as readily as whites, Negroes, or South Sea Islanders. Man's ability to spread northward is, then, either wholly or chiefly cultural and depends mainly on clothes, housing, and the use of fire. His return to the tropics or sub-tropics is marked by a distinct increase in pigmentation, but also by a falling off of energy, and the question naturally arises whether acclimatization is not at the expense of vital energies.[6]

[6] In *Climate and Man*, p. 206.

We thus come back to the first conclusion that, provided men are suitably clothed, the temperature range in which they will produce their greatest and most efficient output is between 60° and 76°, according to the relative humidity, amount of clothing worn, and the worker's own movement at the time. A slight air movement only is assumed.

It will be observed that the relative humidity range is from 40 per cent to 70 per cent and that above or below these limits we pass out of the ideal zone.[7] Very high humidities are almost as oppressive as high temperatures, and although the point has been little studied, my own investigations show that when the relative humidity exceeds 90 per cent, at *any* temperature, there is a feeling of lethargy, headaches are common, work and efficiency suffer. It may be that the change from ideal conditions may come earlier than this, i.e. at about 75 per cent, but accurate detailed information is here lacking. Similarly, at the other end of the range, when humidity is extremely low, there is a nervous excitability and irritation observable that again militates against efficiency. Insomnia also is noticeably common with people who live for months in an artificially overdry environment. Many competent British investigators have stated that an indoor relative humidity of 60 to 70 per cent is ideal, whilst competent American investigators have advocated 40 per cent to 60 per cent as ideal, adding that 30 per cent is 'too dry' and 70 per cent 'too moist.'[8] So that in selecting a range of from 40 per cent to 70 per cent we include all American and European ideals.

It is thus seen that the ideal zone we have sketched may apply to all countries, to all peoples. It may be criticized as being too wide, for it would seem that an ideal zone should

[7] The relative humidity for the entire 24 hours is of course much higher than this. For example, practically all Europe except the Riviera has an average 24-hour relative humidity above 80 per cent in January, and the whole northwest half has above 70 per cent in July. In the United States the humidity in general is less than in Europe, but an average above 70 per cent prevails in three-fourths of the country in January, and in most of the region east of the Mississippi River in July. Noonday humidities are much lower than this. In most of the United States the annual average is between 50 and 70 per cent; for example, 52 at Los Angeles, about 60 at New York, and as high as 73 at Buffalo because of winds from Lake Erie.

[8] See Winslow and Herrington, *Subjective Reactions of Human Beings to Atmospheric Conditions*, in which pleasantness of outdoor atmospheric conditions is chiefly influenced by sunshine and decreasing relative humidity.

not have so great a range as 16° of temperature and 30 per cent of relative humidity.

Nevertheless I accept it in this final form: that where indoor temperatures are above 60° F. and below 76° F. and relative humidities are between 40 per cent and 70 per cent, men work harder and more efficiently than at temperatures and humidities outside this zone. The exact mean may vary from country to country in accordance with clothing, average yearly outside temperatures, heating systems, etc., but the limits of the ideal zone for the human animal indoors appear to be not far from those which I have indicated.

This ideal is, it may be observed, an ideal for the factory—that is to say, for light muscular or sedentary work; and in view of the fact that the United States and Great Britain lead the world in industrial efficiency we have added reasons for accepting the conclusions of investigators in these two countries. For mental activity low humidity percentages are the best, for rest and recuperation a figure approaching 70 per cent may be preferable.[9]

[9] We have admirable corroboration of these figures in Dr. E. G. Dexter's experiments, 1895-1904, in schools, prisons, banks, etc. Low humidities are accompanied by 'excessive restlessness' of mind and body in school children, by 'peculiarities of conduct' among prisoners, and by high nervous tension, insomnia, and irritability among adults generally. High humidities create apathy and listlessness. His ideal temperature range is from 55° to 70° for schools and from 58° to 76° for clerical work. See his *Weather Influences* (1904).

IV

THE IDEAL OUTDOOR CLIMATE

THE ideal indoor conditions have been formulated in terms of two main factors, temperature and relative humidity, with air movement as a third; but in any consideration of outdoor conditions we have to take into account not only the increasing importance of the cooling power of air movement in consequence of its greater velocity out of doors, but also new factors such as the direct heat of the sun and the different habits or activities of human beings.

One of the features of meteorological publications is that the temperature for the day, or the average temperature for months or years, for any given station is always the shade temperature. It is common experience that whilst the pleasantness associated with, say, 65° indoors may be produced by that temperature in the open air if there is bright sunshine and little breeze, it will not continue if there is no sunshine and a strong breeze, for in these conditions it will most certainly feel cooler out of doors than in. Similarly, 70° may be comfortable indoors but very tiring outdoors in strong sunshine. In attempting to arrive at quantitative conclusions we are faced with the following difficulties:

(1) There is a scarcity of exact data on the cooling effect of the wind, though the Pittsburgh investigators have estimated that the cooling effect of a breeze at eight miles per hour (700 feet per minute) on a man stripped to the waist, in warm weather, i.e. about 70°, is to make him feel about 12° cooler.[1] The cooling power of such a breeze is still greater at lower temperatures, but ceases altogether at temperatures over 90°.

(2) There is a similar lack of extensive data on radiation and its effects. Less than a score of places in the world have records over a decade of the amount of thermal radiation re-

[1] See also Vernon and Hill's investigation on these points as recorded in *The Kata Thermometer and Efficiency*.

ceived from sun and sky; and less than 100 places have records of any kind. On the other hand there is much more information about hours of sunshine, which vary from under 1,000 hours per year in parts of Scotland to over 3,600 hours per year in Spain. But from the available statistics we can make certain deductions. Naturally one would expect the yearly intensity to diminish from the Equator to the Poles, but one finds that cloud, dust, smoke, and other impurities in the air considerably check the force of the sun, especially in the more heavily populated areas.

Possibly the Sahara receives the greatest intensity of sunshine of any area of the world, and at Tamanrasset the intensity of solar radiation for 1939 was calculated at 6,400 calorie-grammes per minute per square centimetre of a horizontal surface—an average of 533 per month. It is interesting to compare this apparent maximum with the following places: [2]

Place	*Latitude*	*Monthly Mean of Sunshine*
Tamanrasset (Sahara)	22° 00′	533
Miami (Fla.)	25° 41′	392
New Orleans (La.)	30° 00′	369
Riverside (Calif.)	34° 00′	410
Fresno (Calif.)	36° 43′	466
Algiers (1938-40)	36° 48′	356
Washington, D. C.	38° 56′	341
New York	40° 46′	304
Lincoln (Neb.)	40° 50′	376
Chicago (Ill.)	41° 47′	273
Twin Falls (Idaho)	42° 29′	375
Kew (England) *	51° 30′	140
Fairbanks (Alaska)	64° 52′	226

* Surface placed normal to solar beam, and not horizontal. Figures are for 1934-43.

It is extremely significant that Chicago and New York receive much less solar radiation than Twin Falls or Lincoln, which are approximately on the same parallel of latitude.

The main point I wish to make is that the greater the intensity of solar radiation the greater the heat discomfort for humans, no matter what the thermometer in the shade may

[2] For further information see Sir Napier Shaw: *Manual of Meteorology*, vol. iii, 1930; the *Monthly Weather Review*, April 1941; and the *Annuaire Météorologique de l'Université d'Alger*.

say. I think it is only fair to assume that as we approach the tropics we must add an increasing heat factor to allow for the greater sensation of heat felt by a human being working in the sun. I suggest that at least 1° F. should be added to the shade temperatures for each 5° of latitude from the 40th parallel to the tropics and a further 1° for each 1,000 feet or so of altitude—a point which is referred to in detail on p. 65. Thus whilst the shade temperatures of certain towns in Abyssinia, Mexico, Peru, Ecuador, and Kenya may be much less than those of cities much further from the Equator, the apparent advantage is more than offset by the intense heat felt in the sunshine. It is surprising how quickly human beings can become 'sun sozzled,' and even General Sir Bernard Montgomery in 1943 had to warn his troops in North Africa against over-much sun-bathing because of its enervating effects. The German soldier, he said, was inclined to become a little stupid through over-indulgence in sun-bathing, and in a country such as Tripoli it was noticeable that he was definitely becoming muddle-headed! The sickness rate among the Germans was always far higher than it was in the Eighth Army.

(3) Outdoor work and occupations are usually brisker than factory occupations, but here again we have no means of assessing the difference. The man using the pick or shovel requires cooler conditions than the mechanic, the footballer requires cooler conditions than the chess-player, but it would seem as if the vast range of necessary human activities, in which, of course, we include the business of buying or selling any commodity, domestic duties, and agricultural occupations, require comparable conditions whether they be undertaken in Edinburgh or Khartoum; and whilst it is true that in the realm of sport the inhabitant of the temperate zone will be more active out of doors than the inhabitant of a warmer zone, it is also true that the conditions regarded as ideal for watching a bull-fight will also be ideal for watching a football match, as apart from playing it.

In view of these facts it is only possible to judge that, since wind and radiation tend to oppose each other (the sun gaining the upper hand near to the tropics, and the wind being much stronger than radiation towards the Arctic Circle), their variations may offset one another in climatic areas similar to those

of north-west Europe. But as one goes towards the tropics a greater allowance should be made for the heat of the sun.

Since, therefore, any estimate of what constitutes an ideal outdoor climate can only at best be a guess so long as our knowledge of radiation and wind power is so imperfect, we can only assume that ideal outdoor conditions will approximate fairly closely to the ideal factory conditions already stated. Taking, therefore, the whole body of the world's workers together, from the Egyptian to the Scotsman, we can assert that they will work best and most efficiently out of doors when there is a daily temperature average of between 60° and 76°, with moderate humidity, a gentle breeze, and agreeable sunshine. In conditions such as these the human being is at his healthiest, disease at its lowest, energy at its highest, and the nation that enjoys these conditions, with ideal indoor conditions, will have an immense advantage over its rivals.

We have now reached a very important point in our inquiry, for having determined the approximate ideal climatic conditions both for indoor and outdoor work, the question arises whether we can assume that any person or community of persons born and bred in a climate between these limits, i.e. 60° and 76°, will be more energetic than those born and bred in climates whose temperatures are above or below these limits. The answer is a curious one, and it is that a person born and bred in a climate between those limits will most certainly have more energy than a person born in a warmer climate, but may not have more energy than a person born in a cooler climate.

The reason is not far to seek. Since man first mastered fire, his control of indoor climate has been growing—but mainly in the two directions of warming and drying the air. It is still almost beyond his power economically to cool or to de-humidify an average room more than a few degrees, but even the poorest families in most temperate countries can afford a building and a fire that will give them a temperature of over 60° and a humidity lower than that which prevails out of doors.

On the other hand, in climates much below these limits it becomes more difficult to control cold and to sustain indoor temperatures approaching the ideal, and less energy will consequently be available for other activities. Therefore the ideal climate is one which, whilst never or very rarely passing the

upper 76° limit, yet does not fall so low as to demand great efforts to bring indoor temperatures up to 60° or 70°, whichever is deemed the more desirable.

To put it in another form, the ideal climate is one in which men neither shiver nor perspire when at rest, it being remembered that an ideal outdoor climate is better than the best indoor conditions.

We now come to a fascinating problem which may be summarized thus: if the air conditions above stated are the best for factory work, are they the best for all types of work, and does civilization advance or decline according as man finds conditions near to or far from that ideal?

The answer is a complicated one, but for brevity's sake may be condensed into the following generalization: that the conditions which are best for factory work will produce a rising civilization provided other things are equal, and chief among these other things is clothing. It has already been said that this greatly influences feelings of comfort and energy, and we have first to consider what would be the effect of an almost complete absence of clothing.

In Egypt, in the earliest times of which we have records, we find that the garment most commonly in use was a linen loin-cloth. As time went on this developed into a sort of skirt varying in length, fullness, and folds. Later on both sexes wore a kind of shirt, and over this a loose flowing garment which reached from neck to feet. To these garments were added sandals.[3] In ancient Sumeria, Babylonia, and Assyria, and indeed in all the early civilizations, clothing was of a comparable kind. The question is, what would be ideal external conditions with clothing much cooler and lighter than the European dress of to-day? Fortunately we have here the investigations of Houghten, Yaglou, and others working at the Pittsburgh Research Laboratories. They have estimated that in the ideal range of temperature and humidity already quoted, if there is a slight breeze, a person stripped to the waist will feel from 3° to 6° cooler than he would in still air.

Since, therefore, the clothing of all early civilizations was much cooler than the clothing of to-day, we shall not, perhaps, err greatly if we assume that whilst a temperature range of

[3] *Introductory Guide to the Egyptian Collections in the British Museum*, p. 110.

from 60° to 76° may be ideal to-day, a higher range would be required if clothing reverted again to the loin-cloth or simple shirt and skirt type. Naturally there may be some difference of opinion as to what margin should be allowed for this factor, since it is evident that once again factors other than air movement, such as radiation, have to be taken into account.

As a working generalization I suggest that a temperature range some 2° higher is required to give us approximately ideal conditions for persons lightly clad. In other words, whilst temperatures around 68° may be ideal for persons clothed and shod in European fashion, temperatures around 70° (again with relative humidities between 40 per cent and 70 per cent) may be ideal for persons lightly clad, and even higher temperatures for those very lightly clad.

The last point is important, for if the inference above is correct, or even approximately so, it follows that early civilizations would have had their birth and infancy slightly to the south of the 70° annual isotherm and, as clothing developed, would tend more and more to move northwards.

V

CLIMATE AND HISTORY

HAVING indicated the climatic conditions under which men may develop their greatest energy, we must now see if there are any parts of the world where these conditions exist, and then see whether the inhabitants of those regions are markedly more efficient than those of less favoured regions.

It is evident, to begin with, that, prior to the discovery of heating systems, only a country that was maritime and warm could even approximate these conditions. It is a commonplace of meteorology that the farther one goes from the influence of the sea the greater will be the daily and seasonal variations of temperature,[1] summers will be warmer and winters colder inland than at places in the same latitude on, or near, the coast.

In the second place, it is evident that climate to a certain extent can be controlled. From the time when man first mastered fire, or first began to experiment in house-building or clothing, his control over climatic conditions has been growing, until to-day one can work and play indoors at a temperature of 70° F. even in the depths of a Canadian winter, or when crossing the Equator in a modern liner. Yet mankind, in spite of heating systems, fans, and other methods of modifying the effects of temperature or moisture, is still influenced by the 'natural' climate in which he lives, for as yet his control scarcely extends beyond the walls of any building.

It must be clearly understood that a good climate and climate control are factors of primary importance not only because of the direct bodily comfort they produce, but also because of their strong indirect effect through food, parasites, and mode of living.

[1] The greatest variations may be found at places least subject to sea breezes. If prevailing winds are from the west, then the greatest variations will be found in the east inland areas.

It is a singular irony that many of the greatest inventions that have benefited mankind were the work of men whose names and activities are unknown. The inventor of the wheel, of glass, and of a thousand other appliances and conveniences have long since been forgotten, and it is curious that almost every invention or discovery connected with man's control of climate was considered at the time of so little importance as to remain unrecorded.

The Greeks, however, endeavoured to do a little justice in this direction, for to the legendary Prometheus they assigned the honour of having stolen fire from heaven for the use of mankind. From this time, until within a few hundred years before Christ, man's only protections against the climate were the clothes he wore, the buildings he erected, his brazier, and his hearth.

From the leaves of Adam to the woven fabrics of to-day, clothes have been man's first line of defence against climatic extremes. For shelter from sun, wind, or rain, for the conservation of bodily heat, the effect of clothes on human development can scarcely be exaggerated.

To a lesser extent he obtained protection in the buildings that he erected, whether of branches and reeds or of brick and tile; and to an incalculable extent heating appliances, however elementary, helped to create for him that approach to ideal climatic conditions we have already indicated.

Before the invention of the hypocaust, or the fireplace and chimney, man had little control over the climatic conditions of low temperatures and high humidities, for the brazier and the hearth (unless charcoal was used) created such a smoke that the excessive ventilation needed to clear the air made it impracticable to warm a room effectively.

It follows, therefore, that prior to these developments the nearest approach to ideal conditions would be found in maritime countries with a mean annual temperature of about 70°.[2] In these areas, although winters might be chilly at night, and summers intolerably hot by day, there was always some part

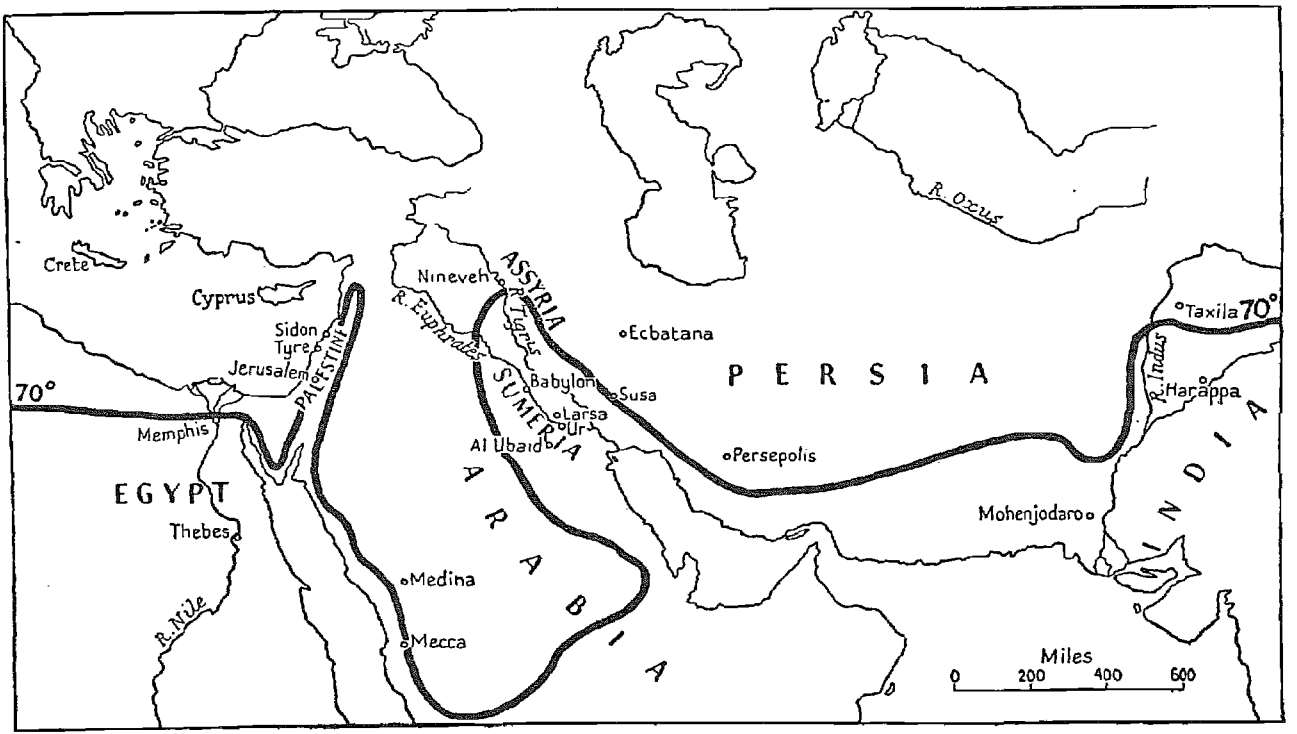
[2] Over 70° would be a still better climate for men who had not perfected the arts of knitting or weaving. Thus the very earliest civilizations (Upper Egypt and Sumeria) had their origin in such warmer areas. On the subject of the development of civilization in China from the second millennium B.C. onwards see page 71 seq.

of the day when the demands on energy in resisting extremes would be less than in other areas to the north or south or inland.

A. THE 70° ISOTHERM

But the best climatic areas of the world will not produce a great civilization if they are continually being overrun by races from less favoured areas. Man-power is essential for the defence of any civilization, and the only maritime areas of the old world adjacent to the 70° isotherm where mankind could multiply to any great extent were the southern Mediterranean, Mesopotamia, Asia Minor, and south-eastern China. Sumeria, Egypt, Babylon, and Assyria all bear out this theory, for when, as a result of political developments, any one of these areas was numerically superior to its nearest rival, it held the lead. Each in turn disintegrated, and the parts fell to the greatest pressure from new unions. Is it an accident that the earliest civilizations are to be found in these regions, or that they continued there for thousands of years until a heating system superior to the brazier and the open hearth was devised? An examination of history will show that prior to 600 B.C. civilizations developed only in the fertile areas along the 70° isotherm, i.e. in the southern Mediterranean and in areas with a comparable climate.

If we trace this 70° annual isotherm we shall readily understand why so few areas of the world could have produced a civilization. Beginning with Madeira, we find that this group of islands appears to have an ideal climate if judged by temperature alone. Funchal, for example, has a mean temperature of 59° in February (the coldest month) and of 72° in August (the warmest month), and the daily temperature range is rarely more than 10°. So that here we have a climate which rarely drops below our low ideal, or exceeds our high ideal, though there are always a few days in the summer when 90° is reached, and a few days in winter when the temperature falls below 47°. It is thus a remarkably mild climate, but its very mildness is due to the surrounding ocean, which in turn produces a high relative humidity at Funchal (70 per cent), and one even higher in the rest of the island. Thus, however delightful the climate may be, it is also conducive to indolence. Similarly the



THE 70° ISOTHERM AND THE *SITES* OF ANCIENT CIVILIZATION.
FOR SIMPLIFICATION, THE ISOTHERM IS SHOWN AS A LINE, BUT IT IS RATHER A SUCCESSION OF AREAS.

Canaries, whilst generally having a climate that is mild and healthy for the greater part of the year, not only have a high relative humidity, but are also exposed to a levante, or hot south-east wind from Africa, which is extremely disagreeable. At Santa Cruz the mean temperature for the year is about 71°, and the daily range seldom exceeds 6° F.

But although these two groups of islands have almost perfect climatic conditions, it is only in comparatively recent times that they have had a considerable population. Even to-day the population of Madeira is only 215,000, whilst that of the Canary Islands is 600,000.

Both groups of island were known to the Phœnicians, and the Romans learned of their existence from Juba, king of Mauretania, whose account of an expedition to the islands about 40 B.C. was preserved by the elder Pliny; but it is extremely improbable that the population of either group ever exceeded 10,000 souls until comparatively recent times.

Turning now to the mainland, we have Agadir and Mogador, the most southern seaports on the Atlantic coast of Morocco, and among the best planned and cleanest towns in the French Colonial Empire. Here the mean temperature of the hottest month is about 70° F., and of the coldest month about 58° F. But one has only to go a few miles inland from these ports to find a vast change in the conditions, and along the whole of this coast there are so few fertile areas in approximately ideal conditions that it is small wonder that it has never produced a great people or great leaders.

From Morocco the 70° isotherm passes with its many involutions along the northern rim of Africa just south of the site of ancient Carthage, where one of the earliest civilizations the world has known, the Phœnician, had its greatest development. From here it runs just north of Siwa on the western boundary of Egypt. Thence to Cairo and ancient Memphis, which have average relative humidities of about 56 per cent and monthly mean temperatures of 55° in January and 82° in July, with a daily range of approximately 20°.

From Egypt the isotherm turns due north, passing near Tyre and Sidon, which, being on the coast, have much higher relative humidities—about 70 per cent. But here again, owing to the hilly nature of this littoral, conditions change quickly. At

Jerusalem and Damascus, for example, the average temperature is 10° lower, without any lessening of humidity; and the Jordan valley, as a whole, is distinctly oppressive during the summer months, whilst snow is not unknown on the hills in the winter months.

Our line[3] now runs almost due east to Baghdad and the site of ancient Nineveh, which has an average annual temperature of 73°—ranging from a mean of 49° in January to 94° in July and August. But here the great heat of the summer is modified by the low relative humidity of 37 per cent compared with 78 per cent in January.

From Baghdad the line runs south-east to ancient Ecbatana and slightly south of Persepolis, and then due east just south of Seistan in Persia. Persepolis has an annual mean of about 69°—ranging from 49° in January to about 89° in July, and relative humidities of 83 per cent and 40 per cent. Our line now passes through the desert area of southern Persia until the fertile area of the Indus valley is reached. Here former centres of Indian civilizations such as Mohenjodaro, Taxila, and Harappa are to be found.

It is interesting to note here that Sir Leonard Woolley infers that the earliest home of civilization was along this 70° isotherm but in a place or places as yet unrevealed. In his *Excavations at Ur,* page 20, he says:

> The Sumerians (whose civilization was already several centuries old by 3500 B.C.) believed that they came into the country with their civilization already formed . . . and if there is a good deal of truth in that tradition, then *it was not in the Euphrates valley that the arts were born,* and though it is not likely to have been the Indus valley either, later research may well discover *some site between these two extremes* . . .

As the line runs east again we are met by growing extremes, until north of Peshawar, with its average of 72.3°, we find a range of 40°—from 51.3° in January to 91.6° in June. Here conditions are most trying during the three summer months, when the temperature averages 90° and the relative humidity is over 60 per cent.

[3] It should be remembered that in some cases, as in Egypt, this 'line' has a depth of nearly two hundred miles, and could better be described as a succession of areas.

From North India the 70° isotherm runs down into the Indo-China peninsula, where it coincides with high humidities nearly the whole year round, and equable climatic conditions are not met with again until we reach the south-eastern part of China. Even then they are accompanied by higher humidities and greater swings of temperature than in Egypt or Persia.

Across the Pacific the 70° isotherm cuts through the desert portions of California, then sweeps south-east through Mexico and Guatemala, and then north again into the Gulf of Mexico somewhere to the south of Galveston. Crossing the Gulf it cuts through the Florida peninsula near Daytona.

An interesting point about this 70° isotherm is that for a very great part of its course it passes through desert, or almost desert, regions. On the other hand, in the areas of high humidity, such as Burma and Indo-China, through which it passes, singularly little civilization appears to have developed. Thus it is that regions such as Mesopotamia and the Nile valley became the homes of early civilizations, for whilst they could not compare with the mildness and healthiness of places such as Mogador, they favoured energy more than did the humid areas of Burma or Indo-China. Moreover, they could sustain a population of many hundreds of thousands, perhaps millions, even with the archaic agricultural methods then in vogue. But the very fact that they had not an ideal climate all the year round meant that the civilization would be slow in development, and easily checked by a few years of unfavourable weather, famine, or war.

But where the 70° annual isotherm does approximately coincide with moderate humidities and with cultivable areas, as at Carthage, Memphis, Antioch, Nineveh, Babylon, Persepolis, and the Indus valley, we find that early civilizations—the Phœnician, the Egyptian, the Assyrian, the Babylonian, the Persian, and the Indian—had their origin and development.

This is, perhaps, the first fact in the history of civilization, that it had its birth and early stages in the well-populated fertile areas adjacent to the 70° annual isotherm. For thousands of years Egypt, Mesopotamia, and Persia led the world in the long progress from barbarism to culture, and the lesser populated areas, such as Crete, Cyprus, and Malta, where early civilizations flourished, are all areas adjacent to the 70° iso-

therm. At the same time, it cannot be too strongly stressed that the 70° isotherm is not stationary. From year to year it varies—and possibly from age to age. Meteorologists tell us that climate has variations in 1,400-year cycles from 'dry-warm' periods[4] to 'cold-wet' periods. If there is anything in this theory, it follows that southern Egypt at some time and Crete at another time may have had climates nearer the ideal than northern Egypt.

In this connection it is interesting to note that great historians and archæologists, such as Dr. Oswald Spengler and Sir Flinders Petrie, have assessed the life of a 'culture' as about 1,400 years. Petrie in an elaborate table gives an average of 1,330 years to the Mediterranean cultures, 1,500 to the Mesopotamian and the Mayan, and 1,800 to the one Indian culture then known.[5] Petrie's conclusion is that since 'the length of the period is practically alike in different parts of the world, it is due to the human constitution rather than to external causes.' It may be interesting to check this by a brief glance at the history of Egypt and India.

B. EGYPT AND INDIA

The written records of Egypt begin about 4200 B.C., when it is stated that the country was invaded by a people of great artistic ability from the Red Sea area. This in itself is a most important fact, for it indicates that prior to the rise of Egypt the world's budding civilization was located farther south, which agrees with the theory already propounded. From 4000 B.C. to 300 B.C. Egypt led the world, but not continuously, for time after time it was invaded, time after time vigour seemed to give place to enfeeblement.

Historians and archæologists tell us that Egyptian civilization begins around 4200 B.C., that around 2800 B.C. was the age of the pyramids and other grand constructions, that around 1400 B.C. was another great period (the Eighteenth Dynasty), and that a final burst began under the Ptolemies about a thousand years later when Egypt became again 'the dominant State in the Mediterranean.' It is remarkable how each of the pe-

[4] See in particular H. W. Clough's recent work in this field published in the *Bulletin of the Am. Met. Soc.*

[5] Sir W. M. Flinders Petrie, *The Revolutions of Civilization*, 1941, p. 110. Dr O. Spengler, *The Decline of the West*, 1933.

riods and their intervening eras of lassitude or decay correspond to the climatic pulsations above indicated, but it is only fair to add that the 12th Dynasty (circa 2000 B.C.) was also one of Egypt's finest periods.

But, more than this, we find that other civilizations emerge at the time of favourable climatic conditions. India is warmer than Egypt and it is, therefore, to be expected that her periods of greatness would occur during the 'cold-wet' periods about 4200, 2800, and 1400 B.C. It is interesting to find that Sir John Marshall, the great Indian archæologist, has charted the last two of these periods with some exactness. The Mohenjodaro civilization, with its 'lively intercourse between the Indus valley and the Elamite and Mesopotamian sites,' occupied the period between 3250 and 2600 B.C. From this period to 1500 B.C. India was constantly invaded, but then, as Dr. J. H. Hutton says:

> Meanwhile in the extreme east of India other movements were going on, as there was a widespread race movement of the southern Mongoloids southwards to the Bay of Bengal and into Indonesia, which had some reflex influence on India from the east. Finally about 1500 B.C. came the Indo-Aryan migration into the Punjab, which first occupied the area between the Indus and the Jamna and later sent colonies across the Jamna into Hindustan. These imposed themselves upon the surviving civilization there, which so reacted to this powerful stimulant as to produce from the combined material the philosophy, religion, art and letters that were the glory of ancient India.

We cannot, of course, postulate with any accuracy as yet the effect of climate on history in such remote periods, but there is a possibility that with ever-extending investigation into 'sunspots' and other phenomena we may reach more precise conclusions regarding weather fluctuations over long periods and their effects upon history.

Egypt and ancient Mesopotamia had one further great advantage over any other areas in that the comparative levelness of their territories, and the fact that their populations were each distributed along navigable rivers, combined to give them rapid means of intercommunication, and consequently the establishment of unified kingdoms. These advantages were not possessed to any degree by the peoples of the Iranian

plateau, which, possibly because of the presence of mountain ranges and the consequent difficulties of travel and communication, remained split into many tribes and minor kingdoms, whilst Egypt and Babylon had achieved their great historical unities. It was not until the coming of Cyrus that these Persian tribes were first welded into a single nation, and they rapidly became one of the foremost people in the world.

It is interesting to note that the Median Kingdom, one of the most powerful of these earlier States, had been founded about 720 B.C. by Deioces, who selected Ecbatana as its capital. The modern Hamadan built near the site of this ancient city lies almost on the 70° isotherm, but as its altitude is over 6,000 feet its average temperature is about 55°. Cyrus became king of Persia in 558 B.C., and seven years later he defeated the combined forces of the Medes, Egyptians, Lydians, and Spartans. By 546 B.C. Sardis had fallen, and during the succeeding twenty years, under Cyrus and his son Cambyses, the Persian power advanced to the Mediterranean, conquering in turn Babylon, Chaldea, Syria, Palestine, and Egypt. The cause of this astonishing success, which in the brief space of a single generation raised a previously secluded tribe to the mastery of the Orient, has been attributed to its military superiority under the great leadership displayed by Cyrus, Cambyses, and Darius, but even Herodotus emphasizes as part of the cause of their success the fact that the Persians were domiciled in a healthy climate and were 'of all mankind the readiest to adopt foreign customs, good or bad.' And we know that in the list of the things which pleased Alexander the Great two centuries later was the splendour of the baths of Darius, which suggests some knowledge of heating methods.

Moreover, the Persians conducted their wars with great humanity and utilized to the full the ablest of those whom they defeated. The ground was prepared for that amalgamation of the Iranians into a single uniform nation, which was completed under the Sassanids. We have no accurate information regarding the climate of Pasargadæ where Cyrus built his capital, or of Persepolis built by Darius somewhat more inland, but a computation of climates of neighbouring towns enables one to estimate their temperatures as averaging 60° to 70°, with comparatively low relative humidities. The greater part of

Persia consists of the great Iranian Plateau, which rises to a height of 4,000 to 8,000 feet and contains within this area a few well-watered regions through which the 70° isotherm now runs. Thus, for example, Shiraz has a mean annual temperature of 65° and Kazerun a mean of about 73°, and it was near Shiraz that the new capital of Persia known as Persepolis was established. Darius succeeded to the throne in 521, and among other indications of the intellectual audacity of these Persians was the canal that he made from the Nile to the Red Sea; and it was he and his son Xerxes who subdued and conquered all enemies to the east, south, and west. But their successors could not withstand the growing might of Macedon, and in 333 Alexander, by defeating the Persians at Issus, overthrew the Achæmenian Empire. For the next few centuries the history of Persia is overshadowed by that of the Hellenistic kingdoms, which, in spite of internal disunity, managed for a time to avert any great catastrophe.

C. GREECE AND ROME

For the first time in history the leadership of civilization left these regions along the 70° annual isotherm, and passed to one in which a means of controlling cold had been discovered that was superior to the open fire or brazier. Apparently the Lacedæmonians were the first to discover such a means, for to them is attributed the discovery of the hypocaust system of heating, in which the floors, and later the walls of buildings, were warmed by the passage of hot air through flues. Dr. Stanley Casson, however, tells me that the Ionians may have been the inventors of this form of central heating, and that at Ephesus the great temple was centrally heated by lignite. The discovery and development of the hypocaust naturally gave the wealthy among the ancients an indoor climate that could be effectively controlled in all but the hottest months, and it is, perhaps, significant that the leadership in culture did not pass from the 70° isothermic area until it was transferred to Greece and Rome.

It is, however, a very moot point how far the Greeks developed the hypocaust. The leading Greek archæologists are practically silent on the subject of how the early Greeks warmed

their houses, and indeed it might be argued that the Greek genius of the 5th century B.C. was not assisted by hypocausts. But it is beyond question that in all the arts of domestic building and architecture the early Greeks were as much ahead of the Egyptians and Persians as the Normans were ahead of the Saxons a thousand years later.

The recent history of western nations teaches us that the adoption of climatic control by any country leads to greater prosperity and greatly increased numbers. If we assume that Greece began the hypocaust system about 700 B.C. and that Rome adopted it somewhat later, we are struck by the same phenomena, for although the population of Greece was never high relatively to its area, the excess, as Gibbon points out, had emigrated as colonists or mercenaries. How great this excess was may be gathered from the number of Greek colonies established about 700 B.C. from the Black Sea to Marseilles; one city alone, Miletus, planting about ninety such colonies. In the following centuries colonizing ceased, but Greek mercenaries are found by their tens of thousands, even in the Persian and Indian armies opposed to Alexander the Great, and in the half-century following Alexander's death Carthage employed a Greek general and Greek mercenaries to defeat Regulus. It is amazing to think that the glory of Athens was founded on a total population of about 290,000, of whom 95,000 were slaves, 35,000 resident aliens, and only about 160,000 free citizens and their families.[6]

It is, perhaps, only too obvious that whilst such a civilization as the Athenian might by constant invention defeat its less civilized foes, even when numerically superior, it would fall quickly before any great aggregation of peoples enjoying an equal civilization.

From Greece the hypocaust system had passed to Persia and Rome. But neither the Greeks nor the Persians developed heating systems as did the Romans, who quickly became the world's supreme plumbers and heating engineers. The houses of the wealthy had central heating, windows were glazed, and water was generally laid on. Just before the Christian era warm public baths became common both in Rome and other Italian

[6] See Gibbon, *Decline and Fall*, World's Classics edition, i, pp. 307 et seq., and Cambridge Ancient History, vol. v, p. 11.

cities. Mæcenas was one of the first who built public baths at his own expense, and from the time of Augustus successive emperors, seeking public favours, spent great sums in constructing enormous buildings which contained not only baths, but also gymnasia, and sometimes even temples, music rooms, theatres, and libraries. They were popular lounges, used by rich and poor alike for rest and recreation. The technical skill displayed by the Romans in the construction of these *thermæ* was of the highest order; the walls and side reservoirs were rendered impervious to water, and the flues for the conveyance of hot air through the walls were of superb construction. These *thermæ* were open from 1 p.m. till dark, and the charge for admission was a quarter of an *as*, less than half a farthing.[7] Yet cheap though this was, the emperors sought and found still greater popularity by making the baths at times free to all. Some idea of the popularity of these 'stately palaces' may be gathered from the fact that the baths of Caracalla at Rome had 1,600 seats of marble, and that this was but the largest of 800 public baths in Rome alone.

Let us consider what this meant to the average inhabitant of an Italian city. The wealthy, of course, had their own heating arrangements, but the mass of the people could go to the baths in the middle of the Italian winter (which at Rome meant an average January temperature of about 44° F., assuming no great climatic change, and at Milan an average January temperature of about 34°) and there find, for a trifling sum, warmth and entertainment for several hours. Perhaps the best comparison is to imagine the population of an American city sweltering in the summer heat, from which they have little protection in their own homes, enabled to go to air-conditioned offices, workshops, or cinemas and there working, or being amused and perhaps instructed, in a cool atmosphere which promotes energy and counteracts the debilitating effect of the natural climate outside.

It is, perhaps, not beyond the bounds of possibility that in the case of the Romans and of the Americans this relief helped to produce a more energetic race. We know that the Romans themselves laid much store by their heating systems, for wherever they went—north, east, or west—they built, of brick and

[7] Gibbon, *op. cit.*, iii, pp. 359-60.

tile, houses so substantial that some have lasted to this day. As far north as the Roman Wall we find these elaborately designed houses, where the Roman leaders could be as free from cold or damp as any of their modern successors. At Woodchester, near Stroud, a Roman villa of the time of Hadrian (A.D. 117-138), covering an area 180 yards by 100 yards, had over 60 rooms, most of which were heated by hot air, distributed from furnaces through terra-cotta tubes; whilst at every Roman military station of importance there were similar buildings, many of which have yielded up their secrets to the pick and brush of archæologists. Similarly at Bulla Regia, Dougga, and other centres in Tunisia may be seen perfect examples of terra-cotta heating flues built into the walls of houses still standing in 1944.

In addition to the hypocaust system, the Romans also used portable stoves and coal-tubs, specimens of which have been discovered in Pompeii. In warming apparatus of this kind the fuel used was charcoal, or dry wood, as producing the least smoke, but even then Horace longed nostalgically for 'the smoke, the wealth, and the street noises of Rome' (*Odes.* Bk. III, 29.12). Whether the Romans had chimneys or not is a disputed point. The usual opinion is that the smoke was not drawn off by means of a flue, but by openings in the roof, windows, and doors; but the use of flues was not unknown to them, and even real grates have been discovered in the ruins of ancient buildings at Pompeii. Chimneys are to be met with there only in baths and bakehouses; but in Rome and north Italy they were used also in dwelling-houses, at least in the days of luxury and refinement.[8] In the most ancient times little was known of chimneys, so that the old *atria* were often disfigured with smoke; but the lodging and working rooms soon began to have both grate and chimney, though the chimney was not high enough to cause a good draught. It may be added that wood and charcoal were the only fuels known to the ancients suitable for indoor purposes. Rome thus developed her control of cold and damp to a point never previously reached by any people, and in addition to this she had the great advantage of a large population.

Where Greece had been limited in her scope by the small

[8] W. A. Becker, *Gallus*, p. 279.

number of her citizens, Rome, from the first junction of the Romans and Sabines to the final extension of the franchise by the emperor Trajan about A.D. 100, admitted all the inhabitants of conquered States to the privileges of Roman citizenship. These newcomers showed their gratitude by almost unwavering loyalty. By contrast, Carthage, like the Greeks, confined privileges to its own citizens, and found that defeat stripped it of its allies.

We have seen that the Athenians, superb in civilization as never a people before, at the period of their great prosperity could number only 160,000 free citizens, but Rome even in the time of Paulus Æmilus (168 B.C.) could count on 337,000 citizens capable of bearing arms. Under Caius Gracchus in 122 B.C., the admission of Italian allies theoretically swelled the numbers of Roman citizens to 4,163,000, and the extension of the franchise to the Gauls augmented them to 6,900,000.

Similarly, whilst Greece chose her leaders from her limited numbers of citizens, Rome could and did choose from a far wider field. Other things being equal, numbers will tell, and when the finest, and most energetic and most cultured city-states the world has ever seen came into conflict with the sheer weight of Rome, Rome won.

In the same manner Carthage was destroyed, and for several centuries from 150 B.C. Rome remained mistress of the known world.

The surprising thing is that Rome should have allowed its superb heating systems and baths to deteriorate. As we have seen, a good climate, indoor or outdoor, helps to produce an energetic people, and the Romans were certainly energetic in these *thermæ*. These not only provided opportunities for hearing lectures, for exercises and business transactions, but also favoured unbounded licence. Thus when Rome became Christian under Constantine in 323, and again in 363 under Jovian —this time permanently—the early Fathers of the Church roundly condemned attendance. They wrote that bathing might be practised for cleanliness or health, but not for pleasure; and by the fifth century many of the large *thermæ* in Rome and other cities fell into decay, and with them the 'luxurious' habits of heated houses. Great was the power of the Church of those days.

Gibbon's account of the mental attitude of these early Fathers is interesting:

> [They] despised all knowledge that was not useful to salvation, and, vainly aspiring to imitate the perfection of angels, they disdained, or affected to disdain, every earthly and corporeal delight . . . The unfeeling candidate for Heaven was instructed, not only to resist the grosser allurements of taste or smell, but even to shut his ears against the profane harmony of sounds, and to view with indifference the most finished productions of human art. Gay apparel, magnificent houses, and elegant furniture were supposed to unite the double guilt of pride and of sensuality . . . In their censures of luxury, the Fathers were extremely minute and circumstantial; and among the various articles which excited their pious indignation [was] the use of warm baths.[9]

Constantine the Great not only gave the Roman Empire a new religion, he gave it a new capital, and the spread of Christianity, carrying with it a more ascetic mode of living, was coincident with the removal of practically the whole of the wealthy or courtly population of Rome and other cities of Italy. The transfer of the seat of government of the Empire from Rome to Constantinople was begun in 324, and in less than a century Constantinople disputed with Rome for pre-eminence both in riches and numbers. It was asserted, and believed, says Gibbon, 'that all the noble families of Rome, the senate, and the equestrian order with their innumerable attendants had followed the Emperor to the Banks of the Propontis . . . and that the lands of Italy long since converted into gardens were at once deprived of cultivation and inhabitants.' It is easy to see that such an event must have carried in its train the decline of the larger houses of Rome and the decay of the hypocaust system of heating. Possibly the growing shortage of wood also had something to do with its abandonment. It is from this time onwards that Gibbon notes the growing laziness of the Romans, their reluctance to undertake military service, the enrolment of barbarians and their promotion to generalships and consulships. The fertile and happy province of Campania, within sixty years of the death of Constantine, was converted into desert and uncultivated land. 'As the footsteps of the barbarians had not yet been seen in Italy, the cause of this amazing desolation, which is recorded in the

[9] Gibbon, op. cit. ii, p. 40.

laws, can be ascribed only to the administration of the Roman emperors.'[10] Yet neither Constantine nor any of his immediate successors was as bad an administrator as Caligula, Claudius, or Nero, and Gibbon records again and again the relaxation of discipline and the growing laziness and indifference that had become characteristic of the people of Rome prior to the onset of the barbarians.

Civil wars, protracted until 353, were the prelude to the barbarian invasion of Gaul. Gibbon points out that these invading races, from Tartars to Huns, had developed a system of trekking north for the summer, and south in winter[11]—thus in their own way modifying their climatic extremes, just as wealthy Americans go to Florida in the winter and Canada in August.

Thus whilst Rome was losing its methods of climatic control and its families who had benefited by them, the barbarians were becoming ever more numerous and vigorous. In 410 Rome fell to Alaric; in 455 it was plundered and pillaged by Genseric, and was in a state of utter decay by the year 600. Thenceforth Italy was divided into a dozen petty States.

But the fall of Rome did not extinguish the civilization of the ancient world. For a time Athens continued as a centre of learning, and even when the Emperor Justinian in 529 closed down the ancient schools in the Greek capital, Constantinople kept alive for several centuries and knowledge of the past. But in Constantinople, as in Greece, the learned Christian was preoccupied with theology, and the Greek interest in science and philosophy for their own sakes was almost dead. Medicine was well cultivated in Byzantium and there seem to have been a few small additions to the knowledge of the ancients, but substantially Byzantine laymen were content to copy and comment on their forerunners without much attempt at originality.[12]

Moreover Constantinople was seldom the united capital of a united empire. Religious discord led to strife. Constantine's successors varied from pompous fools to the meteoric and su-

[10] Gibbon, op. cit. ii, ch. 7, p. 220.
[11] Ibid. iii, ch. 26, p. 89.
[12] Sherwood Taylor, *A Short History of Science.*

perb Julian, silver-tongued and adventurous, and to Justinian the Great, who ascended the imperial throne in 527. A great law-giver, a great builder, a great theologian, and a great conqueror, his standards went in triumph to Italy, the Levant, and northern Africa. Yet under him an insurrection resulted in the burning of the city and the loss of 80,000 lives. The cathedral of St. Sophia, beautiful baths, and other buildings were raised upon the ruins, and wealth and prosperity returned, in spite of Hun and Vandal. Constantinople was mistress of the eastern world. 'Constantinople,' wrote Finlay in his *History of the Byzantine Empire* (1854), 'was as much superior to every city in the civilized world in wealth and commerce, as London now is to other European capitals.'

Justinian's successors were tyrants, drunkards, and madmen until Heraclius came—only to be faced with the usurping power of the Arabs. There was a brief return of culture and prosperity under Basil I, and then an era commencing with a rebellion by the great nobles of Asia and ending, to quote Finlay, 'when in 1203 a band of 20,000 adventurers, masked as crusaders, put an end to the Roman Empire in the East.'

The sack of Constantinople by the Crusaders almost put an end to the Greek culture which still continued there. There survived, however, the manuscripts of the Greek authors which, after the fall of Constantinople to the Turks in 1453, were to set western Europe alight with learning.

It is interesting to note that Constantinople is month by month about 3° F. cooler than Rome, but there is little evidence that the Romans who migrated to Constantinople built houses on the same system as in Rome, i.e. with the hypocaust system of heating. Gibbon and Bury are silent on this point but they both point out that whereas Rome had 800 public baths, Constantinople, even a century after its foundation, had only eight. If the building of private houses with the hypocaust system had been in the same proportion there would have been a significant difference in the control of indoor conditions between the two empires.

It is perhaps more than a coincidence that the rise of Greece and Rome should follow the advent of heating systems and that the fall of the Roman Empire should follow their abandon-

ment. A stranger coincidence still is that with the decline of Rome and the decay or neglect of heating systems in Europe, world power should pass back to the warmer countries lying along the 70° F. isotherm.

D. ARABIA AND ISLAM

From A.D. 500 to approximately 1300 Europe, excepting only the southern Mediterranean fringe and Constantinople, endured the long depression of the Dark Ages, and fell back on earlier types of domestic architecture and heating. The arts of brick- and tile-making were forgotten or never learnt by the barbarian and were unknown to the Saxons and Normans. The only type of heating was, once again, the open fire. It is significant that during this period civilization in Europe halted in its spectacular progress and returned to south-east Asia and the southern fringe of the Mediterranean. While Europe shivered, the people of the Near East shook off the last relics of Roman overlordship and once again became the conquerors.

With the decline of the power of Rome in the fifth century, which, as we have seen, was preceded and accompanied by the destruction or neglect of the heating devices that were of such service during the winter months, the central points of power gradually passed back to those areas which had been leaders of civilization prior to the Greek and Roman Empires—that is, to the countries south and east of the Mediterranean and in the area formerly known as Sumeria.

Meanwhile, about A.D. 230, Persepolis became once more the capital of the Persian Empire, but it was not until long after the decline of the Roman power, in 531, that Chosroes raised the empire to a condition of prosperity which it had long failed to reach, and compelled the Byzantine Justinian to pay him tribute. About this latter date the Persian capital was transferred to El Medain (Ctesiphon), a few miles from ancient Babylon and the more modern Baghdad. But Persia, besides suffering from the long and exhausting wars with the eastern Roman Empire, was stricken with civil war from time to time, until from 627 to 631, as Gibbon tells us, 'in the space of four years the royal title was assumed by nine candidates who dis-

puted, with the sword and dagger, the fragments of an exhausted monarchy.'

At this period there arose a religious power that for the first time in history united the Arab tribes under a single banner. Arabia is, on the whole, one of the hottest regions of the earth, especially along the coasts of the Persian Gulf and the southern half of the Red Sea, but in the interior, in northern and central Arabia, the nights are cool, and the winter is fresh and invigorating, while on the highlands of Yemen, Asir, and Oman, the summer heat is not excessive, and the winters are, comparatively speaking, cold.

Here in two of the somewhat better climate areas—the neighbourhood of Medina and that of Mecca—Mohammed lived and worked. Long before his birth at Mecca in A.D. 560 or 559 the Arab world had reached a high level of civilization. Writing was a fine art, and poetry, oratory, and eloquence were held in general esteem. Architecture was advanced, and the Arabs were masters at building wells and storage tanks, and there are still remains of castle and city walls that existed centuries before the Mohammedan era. Mecca itself, possibly on account of its sanctuary, had long been a great centre of commerce and free from the shedding of blood.

Why is it that this strong, dignified people should suddenly shake off their inertia and become the makers of a great Saracen Empire, carry a religious creed half across the world, disseminate scientific knowledge, and then sink back, a spent power, into their desert? Possibly the initial cause was that Mohammed provided a religious doctrine to which all Arab tribes could, and did eventually, adhere. His immediate successors at the head of a united aggregation of peoples carried the banner of the Prophet far beyond the confines of Arabia, particularly Omar who, within ten years of Mohammed's death (634-644), added Syria, Iraq, and Egypt to the Islamic Empire. Under Othman (644-656) Afghanistan, Turkistan, Armenia, and Khorasan were brought under its sway.

The Arabs, thus emerging from their desert homes, became the aristocracy of Islam. Conquered nations, even of much higher civilization, when they reached the faith fell into an altogether lower caste. . . . This ascendancy, social, military and political, the Arab maintained for upwards of two centuries. Then they were

gradually supplanted throughout the East by Turks and Persians . . . But in Spain and Africa the prestige of Arab blood survived.[13]

Under Mohammed and his immediate successors the tribes of Arabia were united in one faith. Those who were disaffected were crushed or expatriated. Successful expeditions into Syria and Mesopotamia not only provided booty for all the tribes, but also additional wives. With such a trinity of incentives—the religious, the mercenary, and the voluptuous—small wonder that the Arab forces went from victory to victory.

In 641 Egypt was added to the Arab dominions. The province fell after a campaign lasting only a year, apparently surrendered by the eastern Roman Emperor without any great attempt to vindicate the former renown of Roman or Greek arms.[14] The land was left in the hands of the previous owners, and became the granary of Arabia, as it had been the granary of the Roman Empire.

The Arabs were thus the champions of Islam—soldiers and nothing else. They might not settle down in any of the conquered lands as cultivators, while for commerce or other civil occupation, warlike life offered little leisure. They lived on the fat of conquered provinces. Under Omar the income of the commonwealth was divided as heretofore amongst the Faithful, but henceforward according to religious merit or military service. Wives, widows, and children too had their stipend, and every Arab soul was rated at what it was worth. A whole people subsidized by spoils on the basis of equal brotherhood is a spectacle without parallel in the world. Martial genius was maintained by the rewards offered. The nation was an army mobilized, with promise of a never-ending stream of recruits, for whilst none but Arabs could form part of this ennobled soldiery, the whole progeny of the Arab sire, whatever the mother, was Arab. Arab women as a rule married only Arab husbands, but the other sex were free to contract marriage with the women of conquered lands, and the children, whether

[13] Sir William Muir, *The Caliphate: Rise, Decline, and Fall*, p. 44.

[14] At the time of the conquest, Alexandria was the second city in the attenuated eastern Roman Empire—a seat of commerce, luxury, and letters. The vast population of this city, well over a million, was provided in unexampled profusion with theatres, baths, and places of amusement; according to Muir, there were possibly 4,000 baths and 400 theatres (Sir William Muir, op. cit. pp. 159 et seq.).

the mother were slave or free, Muslim, Jew, or Christian, were equal in legitimacy and equally Arab.

How productive this system was may be gauged by the fact that one of the early Arab generals, Khalid ibn Welid, lost forty of his sons in the plague of 639.[15] 'We shall not greatly err,' says Muir, 'if we assume that before Omar's death the Arabs beyond the limit of Arabia proper numbered half a million, and before long were doubled and perhaps quadrupled.'

But as yet the Arabs were in no sense a civilizing force. Apart from war and faction, Muslim life gradually became idle, inactive, and sanctimoniously voluptuous. In the greater cities intemperance and libertinism began to spread, checked only by the hallowed associations of Medina, which encouraged a severe simplicity of life.

In the early part of the eighth century, within a hundred years of Mohammed's death, north-western Africa, southern Spain, and north-west India were added to Islam—which in each case was aided by troops from the invaded areas. Inroads were made into France—assisted by disloyal chiefs of the invaded country, until the victory of Charles Martel at Tours in 732 placed a check on the expansion of Islam.

Meanwhile the capital of the Arab Empire, which had been at Mecca until 657, was transferred to El Kuffa, and from there, under different dynasties, to various cities in Iraq and Syria, Damascus and Baghdad being among the more important, and it was in these centres, and not until this period, that a civilization began to develop. As Buckle says, in his *History of Civilization,* 'In Arabia they had been a mere race of wandering shepherds; in their new abodes they became the founders of mighty empires—they built cities, endowed schools, collected libraries; and the traces of their power are still to be seen at Cordova, at Baghdad, and at Delhi.'

During the whole of its first hundred years Islam had been a religious, but not necessarily a civilizing, force. Beyond the Koran they added little, while they destroyed much. With the rise of Persian influence, however, there opened an era of culture, toleration, scientific research, and luxury. The ancient lands of Babylon, Assyria, Egypt, and Carthage bred a race of

[15] Muir, op. cit. p. 145.

warriors, scientists, and missionaries equal to those of any earlier time. Scholars from the East held high and influential place, while the Arabs, who had ever looked with contempt upon nations every way their superiors in science, art, and culture, now were fast learning from those whom they had despised.[16] Literature, history, medicine, and especially astronomy began to be studied, and practically all the knowledge of medicine and mathematics, geography and applied sciences, and astrology reposed for several hundred years in Baghdad, Damascus, and Cordova. The culture of Baghdad was mainly due to the people of Persia and Khorasan, as well as in some degree to the more liberal intercourse with the Greek Empire. Within fifty years of the founding of the Abbasid dynasty in 750 the court of the Caliph had become the centre to which from all parts flocked the wise and the learned, and at which rhetoric, poetry, history, and law, as well as science, medicine, music, and the arts, met with a genial and princely reception—all of which bore ample fruit in the succeeding reigns.[17]

Arnold Wood points out that while Europe sat in darkness Baghdad became the centre of a splendid civilization. Mohammedans and not Christians became heirs to Greek culture, especially in respect of geographical knowledge. Ptolemy remained unread by Europeans until the fifteenth century, but already in the ninth century his books were translated into Arabic, and inspired a native Arabic science, which in turn in the thirteenth century was accepted by Roger Bacon. By the ninth century observatories were founded at Baghdad and at Damascus, and a school of geographical science was formed. Arabian travellers co-operated with men of science and surveyed every sea from Spain to China, Cairo to Madagascar, from Java to Canton. Even the Indian Ocean, as Sir William Hunter said, 'became an outlying domain of Islam.'

Thus, as in the case of Greece and Rome, civilization centred again in the midst of the greatest aggregation of people enjoying for the time the nearest approach to ideal conditions. The neglect of heating systems and the consequent loss of control of indoor conditions by the Greeks and Romans, or their successors in various territories, meant that the focal point of civilization would again move south until that con-

[16] Ibid. p. 465. [17] Ibid. p. 486.

trol was renewed. The Arab hegemony gave way to the suppleness of the Persian, and the Persian in controlling the Arab Empire controlled it from the site of previous civilizations. The pendulum of civilization after having been pinned to the north for a thousand years had, after a few oscillations, swung back to its former arc where it had been before the hypocaust had been invented, i.e. in the fertile areas along the 70° isotherm.

In the absence, throughout the world, of any heating or cooling systems, the peoples of Sumeria, with its twin rivers the Tigris and the Euphrates, or Egypt with the Nile, enjoying a bearable (but by no means perfect) climate, were bound to lead. But if either of these regions was partitioned or distracted by internal feuds, or other causes of trouble, then leadership might well pass temporarily to Syria, Persia, or Carthage. But a united Sumeria or Egypt, in an age before artificial heating was adopted, was the inevitable centre of civilization in the old world.

E. SPAIN AND PORTUGAL

But now the Arab Empire, which had spread over much of the area previously occupied by Rome, began to break up. Faction had always been rife, and the history of the Arabs is a record of constant internal faction and rebellion. The fervour of religious enthusiasm had diminished, and self-aggrandizement had taken the place of passion for national glory and extension of the Faith. The Saracen was no longer the conqueror of the world.[18] The Caliphate was no longer co-extensive with Islam nor dependent upon the Arabs. The Abbasid dynasty (750-1258) was dependent upon levies from Persia and Khorasan, and gradually Turks from the Oxus, barbarian and savage, acquired high positions in the army. Spain became a separate state of Islam from about 750; Idris established a separate dynasty at Tangiers a few years later; while in the East, as time rolled on, other independent dynasties arose.

It may be thought strange that Spain, lying in the same latitude as Italy and Greece, should have contributed so little to civilization until this period, apart from a brief period of distinction under the influence of Rome.

[18] *Ibid.* p. 433.

But from the time of the Romans, Spain, like Italy, had been carved up by Goths into a series of petty states, each warring with the other until, in 711, the country was overrun by the Moors under Musa and Tarik, aided by Count Julian, the chief of one of the noblest families in Spain and a warrior of renown, at the head of 10,000 men.

In southern Spain, which as we have seen has a climate comparable to that of Egypt,[19] the Moors multiplied until Spain could boast a larger population than any other comparable Mediterranean area. In the middle of the tenth century, when Europe at large touched the lowest depths of the Dark Ages, the southern part of Spain displayed perhaps the most brilliant civilization since the days of Pericles. Under Abd-el-Rahman III (912-61) a patient and skilful agriculture, superb craftsmanship, and the most honourable commerce in the world, created a wealth and prosperity that was without its parallel. It is noteworthy that both in the construction of houses and baths this territory then led the world. The population of this southern half of Spain was then about 30 million. But the civilization that might have continued to flourish here was kept in check for 750 years whilst the tide of war between Moor and Christian surged backwards and forwards—now with the Moors bursting into France, now with the Spaniards regaining even Gibraltar. Not until 1462 were the Moors finally ejected from Gibraltar and southern Spain.

Almost at the same time Spain became united under Ferdinand and Isabella. Ferdinand, heir to the throne of Aragon, and Isabella, Queen of Castile, were married in 1469, and a few years later the two kingdoms, so often at war with one another, were united, and Spain now represented the greatest aggregation of peoples under a single ruler within the Mediterranean area. Italy was still a bewildering patchwork of medieval states, Islam was split into a dozen fragments, and nowhere in the Mediterranean was there a people so united or so ably led as the Spaniards at this period. Within two generations from the first voyage of Columbus, in 1492, Spain had extended her dominions from the Netherlands to Peru. The world had never seen a larger or richer empire. Portugal too

[19] Seville has a mean annual temperature of 68° ranging from 52° to 85°, Cairo has a mean annual temperature of 70° ranging from 55° to 83°.

was at her zenith, and her empire was second only to that of Spain.

But half a century later, in 1594, the first Spanish census gave a population of only 8,206,791, compared with 30,000,000 under Abd-el-Rahman III about 950.

The figures are remarkable enough as indicating the loss of status that may befall a country through a decrease in numbers. The decimation that the wars with the Moors could not produce was brought about by American expeditions, the Inquisition, and warfare both at home and abroad.

The Spanish *conquistadores,* at once brave and ingenious, begot few children in their own country, but many half-castes in South America, thus leaving Spain grievously deficient in great men, while such of these as did remain could scarcely hope to escape civil war or murder. The fields of Spain were untilled, towns were deserted, and whole populations starving. To add to the decline, decrees in 1609-10 expelled from Spain the industrious descendants of the Moors, and half a million of her best citizens were hounded out. During the next century civil wars and foreign wars continued until, under the profligate Philip IV (1621-65) and the semi-idiot Charles II (1665-1700), Spain was stripped of power, prestige, and resources. It succumbed to nations not numerically stronger, but employing better methods of climate control.

F. EARLY CIVILIZATIONS IN AMERICA

While Europe was thus awakening from the torpor of the Dark Ages there were developing in America three civilizations that have aroused the interest of the world—the civilizations of Mexico, Peru, and of the Guatemalan highlands.

America was probably first inhabited some ten or fifteen thousand years ago,[20] the first immigrants apparently arriving from Asia by way of Bering Strait and Alaska, either in boats or across the ice. Almost certainly there was no mass migration, possibly hundreds of years elapsing in some cases between the crossing of one group and that of the next. These first immigrants were on a very low cultural plane, probably resembling in this respect middle or late palæolithic man in Europe.

[20] Estimates vary from 70,000 years ago (Antevs) to 2000 B.C. (Spinden).

Wearing skins for warmth, they hunted game with spears and lived either in caves and rock-shelters or in very primitive shelters erected in the open.

By degrees, these immigrants and their descendants spread all over this vast continent from the frozen north to the temperate coastal strip of California and the Mexican plateau, and to the steaming Amazonian jungles and the sub-antarctic Tierra del Fuego.

America is a continent of marked physical contrasts. In the same latitude one can pass from arid coastal plains across snow-clad peaks into tropical jungle. Within a distance of three hundred miles one finds these overwhelming contrasts of sandy waste and impenetrable jungle teeming with life. Travelling from north to south the transition is less abrupt, but varies from the frozen spaces of northern Canada to the tropical deserts of northern Mexico, from the steaming jungles of Brazil and the woodlands and swamps of Paraguay, to the treeless pampas of the Argentine and down into south Patagonia and Tierra del Fuego, a region of sub-antarctic flora and fauna. America thus presents the extremes of heat and cold, of desert, forest, and jungle. Somewhere within its limits every type of vegetation can be found.

The contrasts in civilization are as marked as those of physical geography. On the one hand areas lying well within the tropics nurtured the most advanced civilizations of the new world; on the other Tierra del Fuego is still the home of some of the most primitive tribes in the world.

Here again we may note that, as in the old world, the gradual development from barbarism to civilization began and flourished in fertile areas where the climate is most congenial; but in this vast continent only a few small areas have an equable climate all the year round, mostly on the sides of the mountain ranges that skirt the west coast. Everywhere else either the ranges of temperature are great, or heat, cold, or humidity are excessive. Consequently, to primitive races, with no knowledge of heating systems, the most congenial climatic areas were the fertile valleys in the tropical highlands, even though the average shade temperatures are several degrees lower than those of the riverain civilizations in the old world. This is a very interesting point, and to it we can bring the great authority of

Roget, who, in his *Altitude and Health* (p. 53 seq.), shows that in the Alps there are three horizontal layers of climate, namely, (1) the valleys below 3,000 feet, which are cold and sunless, (2) the layer of moisture condensation, up to about 4,000 feet, which is damp and cold, (3) the elevated areas, over 4,000 feet, which enjoy bright sunshine with great solar intensity at all seasons. Roget's conclusions have been amply corroborated by Professor Dorno of Davos, who has shown that although the shade temperatures of Kew and Potsdam are 9° F. higher than Davos the year round, Davos is actually warmer in terms of human comfort, as indicated by the kata-thermometer, mainly because of the intensity of solar radiation in the rarefied atmosphere of 12,000 feet altitude.

In the tropical highlands this difference would surely be accentuated, owing to still greater solar intensity. The question follows: What allowance should we make for this sunshine factor? I suggest that it should be at least 1° F. per 1,000 feet of altitude above the layer of moisture condensation, but later research may show that it is more likely to be nearer 2° F. per 1,000 feet of altitude. It is noteworthy that the Inca civilizations were born at an elevation of over 8,500 feet in average temperatures of 58° F. or less; the Aztec civilizations developed at 7,000 feet in a mean temperature of about 60°, and the Maya civilizations developed in areas over 4,000 feet high in average temperatures (as far as one can estimate) of between 65° and 68° F. Prescott, the great historian of the Aztecs and the Incas, lays stress upon the salubrious climate of the areas that formed the headquarters of these peoples. Speaking of the Aztecs, 'a poor, but wandering tribe, a fierce and brutal race,' which, owing to an oracle, settled in the valley of Mexico, he says:

'This valley is situated at an altitude of 7,500 ft. and has a circumference of about 200 miles, and in those days contained five large lakes of much greater area than they are to-day.'[21] 'This tableland enjoys,' says Prescott, 'a mean temperature not lower than that of the central parts of Italy'—i.e. 62° F. 'In the time of the Aztecs the tableland was thickly covered with larch, oak, cypress, and other forest-trees.'[22]

To-day Mexico City has a mean annual temperature of 60°

[21] *Atlas Géographique de la Nouvelle Espagne*, 1811, i, p. 334.
[22] *History of the Conquest of Mexico*, i, p. 9.

F., ranging from a monthly mean of 54° in December to 65° in May, and the relative humidity varies from 47 per cent in April to 71 per cent in September.

Gradually the Aztecs conquered all adjacent territories until their empire comprehended the country between the 14th and 21st degrees of latitude North, and their lake-island capital, founded in 1325, attained the first rank in the western world.[23] They created 'the nearest approach to civilization to be met with anciently on the North American continent.' 'The degree of civilization which they had reached, as inferred by their political institutions, may be considered, perhaps, not much short of that enjoyed by our Saxon ancestors, under Alfred. In respect to the nature of it, they may be better compared with the Egyptians; and the examination of their social relations and culture may suggest still stronger points of resemblance to that ancient people' (i, 35). 'It is a further proof of civilized habits that the Spaniards found barbers' shops, and baths, both of vapour and hot water, familiarly used by the inhabitants' (i, 291). Their homes were well built, but had neither windows nor doors, hanging mats being used for the latter.

In comparing the Aztec and Inca civilizations Prescott says, 'Both nations commenced their career of conquest at dates, it may be, not far removed from each other. And it is worthy of notice that in America the elevated region along the crests of the great mountain ranges should have been the chosen seat of civilization in both hemispheres.'[24] He traces the source of the Inca civilization to Cuzco, which became the worthy metropolis of a great and flourishing monarchy, but later investigators have traced it to Arequipa. Like Mexico City, both Cuzco and Arequipa enjoy a genial and salubrious temperature, but are several degrees cooler than the 70° annual isotherm. Possibly the mildness of the winters and the heat of the tropical sun compensate for the lower average shade temperatures. From Cuzco, 'under the mild and benevolent sceptre of the Incas, a community gradually extended itself along the surface of the broad tableland, which asserted its superiority over the surrounding tribes.' In the fifteenth century Chili and

[23] Ibid. ii, p. 233.
[24] *History of the Conquest of Peru*, p. 97.

the powerful kingdom of Quito were added to the Peruvian Empire. Here an industrious population had settled along the lofty regions of the plateau, and towns and hamlets clustering amidst orchards and wide-spreading gardens seemed suspended in the air far above the ordinary elevation of the clouds. This region—i.e. the plateau of Quito—is at a height of between 9,000 and 10,000 ft. above the sea.

Like Mexico, Peru fell before the Spaniards, and Pizarro fixed the new capital at Lima only six miles from the sea.

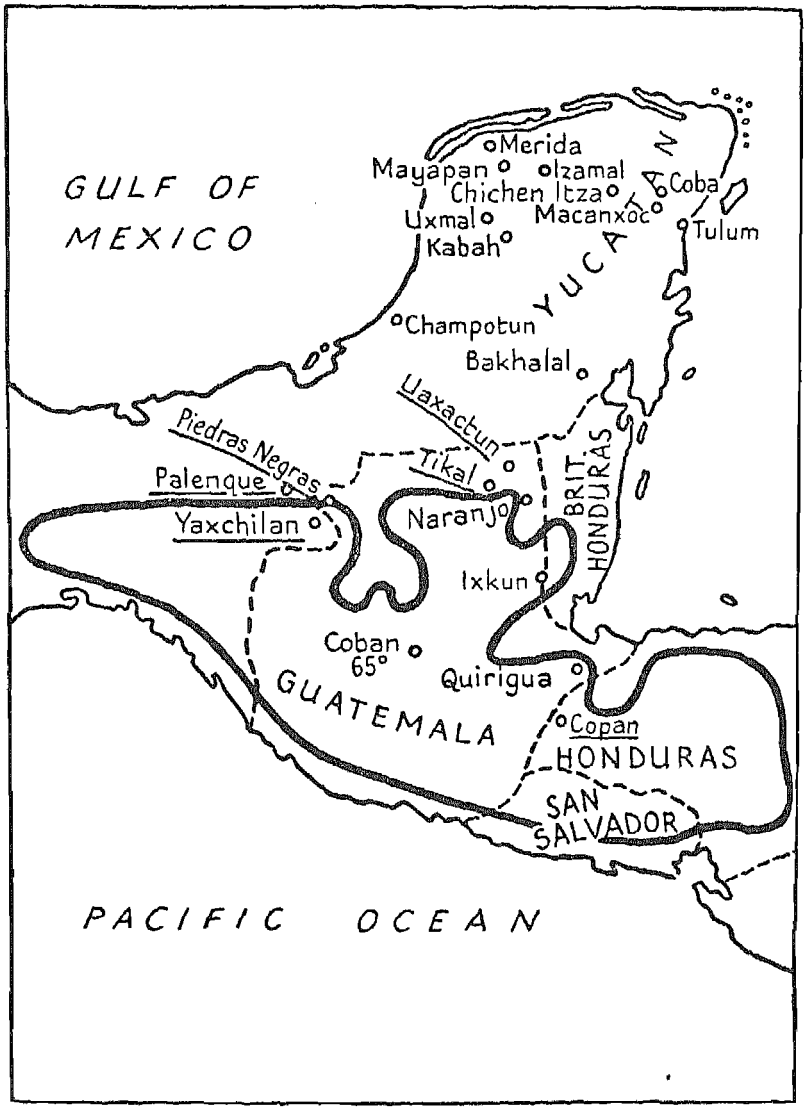
There is one further American civilization to be considered, that of the Mayas in Yucatan, an area apparently much *warmer* than the 70° isotherm. But a closer review of the history of the Mayas reveals the fact that their civilization started in the Central American highlands almost along the line of the 68° isotherm, and that when it had attained its highest point the people removed to less congenial climatic areas, and that here, within a comparatively short space of time, their civilization, after a last flowering, decayed.

The region (see map, p. 68) in which their civilization developed and declined is divided to-day between Mexico, Guatemala, British Honduras, Honduras, and San Salvador, but if we view it as a physical unit we can divide it roughly into two main areas—the lowlands and the highlands—the lowlands being adjacent to the sea coast and including also Campeche and Yucatan, and the highlands covering the more southerly portion. Near the coast the climate is distinctly unhealthy, with malarial fevers very prevalent. The Atlantic coast has a further disadvantage of a heavy rainfall and high humidity, and there is a local saying at Golfo Dolce that it rains thirteen months in the year. On the highlands, however, the climate is healthy.

Unfortunately, we have no accurate meteorological maps for this region, but if we take the figures available for the modern cities in this area, we get the 68° F. annual isotherm in the position indicated on the map. Here again it is remarkable that this should cut through nearly all the sites where the Mayan civilization began and developed.

According to J. Eric Thompson,[25] the earliest known Mayan city is Uaxactun, in the northern Peten district, which dates

[25] *The Civilization of the Mayas*, Chicago Natural History Museum, 1927. See also S. G. Morley, *The Ancient Maya*, 1946.



THE MAYA AREA WITH PRINCIPAL CITIES.

THE THICK LINE INDICATES APPROXIMATELY THE 68° ISOTHERM, AND THE UNDERLINED TOWNS ARE THOSE WHERE THE MAYAN CIVILIZATION HAD ITS BIRTH AND ACHIEVED ITS GREATEST HEIGHTS.

from about A.D. 300. Excavations have revealed evidence of a very long occupation. Other important early Mayan cities, all dating from the fifth century, are Copan, Tikal, Yaxchilan, Piedras Negras, and Palenque. Tikal is famous for its great extent as well as for the great height of the pyramids erected there. Yaxchilan and Piedras Negras reached a higher level in the sculpture of stone than any other Maya city. Palenque is famed for its low-relief tablets with their simple lines and exquisite work in stucco. Copan, on the other hand, was the intellectual centre of the Mayas, for here the greatest advances in astronomy and mathematics were made. Nevertheless, Copan's art and architecture were not unworthy of her rivals.

In the sixth and seventh centuries a large number of cities or religious centres came into prominence, of which Quirigua, Naranjo, and Coba were the most important. The art of these cities was, with few exceptions, distinctly provincial, falling far below the best work of the cities founded earlier.

This was a period of unexampled prosperity, and the population must have been very dense. The dwelling houses, which were made of wood, thatch, and adobe, have crumbled into ruins, leaving no trace behind, but the many cities with their innumerable artificial mounds, palaces, and temples must have demanded the labour of a huge population for their erection, especially as only stone tools were used.

Just as Athens was crushed at the height of her power, so the Mayan Empire was destined to fall within a century of her greatest period. In the middle of the eighth century, one by one these proud cities ceased all civic activities. One or two, such as Tikal, continued to flourish for a time, but by A.D. 890 the last city of the Old Empire had ceased to erect stelæ and elaborate edifices.

Many theories have been brought forward to account for this cessation of activity. The view has been advanced that the Mayas were forced to evacuate territory owing to pressure from Mexican invaders. It is very doubtful that this was indeed the main reason. If the Mayas abandoned their territory in face of the invaders from the north, it would be only natural to expect that the Mexican arts and crafts would be discernible, but such is not the case.

It has been suggested that wasteful methods of agriculture made

conditions harder and harder for the Mayas in the old territories and that eventually city after city had to be abandoned owing to the exhaustion of the surrounding soil. This would have resulted in an annual decline of production, which continued until famine stared the inhabitants in the face.

The Maya system of agriculture was primitive. Land suitable for agriculture was prepared by burning off the trees and undergrowth. After the first rains, the sower, armed with a bag of seed and a sharp-pointed stick, crossed and recrossed the field, making a hole with his stick in the ground at every pace, and throwing a few grains of maize into the pit. At the end of the season the field was abandoned, and next year the Maya farmer marked out a new piece of land to be cleared and sown. In the course of time, and with the large increase of population that undoubtedly occurred, the Mayas must have been driven farther and farther afield in search of virgin soil. The exhausted soils nearer home must have been resown after shorter and shorter periods of recuperation. In time the yield of the district would have fallen below the level of consumption and, faced with the alternative of evacuation or starvation, the people chose the former.

There are other theories to account for an actual exodus of the whole population from the Old Empire region, among which pestilences and climatic changes figure. Actually it would seem that this whole area continued to be occupied long after the religious centres fell into neglect. It is not improbable that the governing priest class was overthrown by a revolt of the masses.[20]

Most of the tribes now moved north, and the Itzas around A.D. 800 arrived at Chichen Itza and there constructed edifices which for size and decoration were far superior to those of the earlier civilization. At the end of the century the Itzas abandoned the city and moved across to Champotun on the west coast, where they lived in peace for a period of 260 years. Other Mayan tribes appear to have become comparative nomads and trekked from area to area. It is evident that for some reason or other the bulk of the Mayan tribes left the good climatic areas of the highlands for the more prolific but less energetic lowlands. Within a short time their art and civilization decayed, for, as Thompson says:

These perpetual shiftings that had lasted almost four hundred years had had a drastic effect on Mayan civilization; the art which had been the glory of the Old Empire had suffered a blow from which it never recovered; the sculptures of Yucatan never reached the high level attained in the ninth cycle . . .

[20] Thompson, op. cit.

Influences from Mexico had undoubtedly made themselves felt at Chichen Itza considerably earlier than this first mention of them in the historical outline. There is reason to believe that Mexicans reached Chichen Itza at the time the Itzas returned to their old capital and the league of Mayapan was established (about A.D. 1260). These Mexican invaders probably hailed from the area bounded by the modern states of Puebla and Vera Cruz, and were probably of Toltec affinities, both cultural and racial. They were instrumental in introducing a new religion, a new art, and possibly new methods of warfare. Apparently, they established their rule at Chichen Itza, and the profound influence they exerted can be seen to this day in the large number of beautiful palaces, temples and colonnades they caused to be erected.[27]

For a time this striking civilization continued to flourish, but in the middle of the sixteenth century came the Spanish invasion. The Mayas put up a stout but ineffectual resistance, and within a few decades the Mayan civilization had vanished.

It is, perhaps, strange that the territories, Mexico, Peru, and the Guatemalan highlands, in which these American civilizations grew should all be areas most congenial to men climatically, in the absence of any climate control. Had any of them been capable of supporting a population comparable to that of Egypt or Italy, or had they been occupied a few centuries earlier, history might have taken a very different course.

G. CHINA

So far, the civilizations we have considered have been those which were primarily initiators, and only to a lesser extent imitators of neighbouring civilizations, but, in the whole of eastern Asia, all civilizations, whether those of China, Japan, or Indo-China, were adaptations of civilizations which had developed elsewhere. In the whole of this region, from north-east Siberia to Indo-China, there are few areas where the yearly and even daily extremes of temperature and humidity are not such as to take heavy toll of human efficiency and ingenuity. Such civilizations as did appear in eastern Asia owed their origin to the Euphrates Valley or India, and a lapse of centuries often occurred between even minor advances.

From Babylon to China is 3,000 miles by land, and the only

[27] Ibid.

connecting routes in early times were the inhospitable 'steppe corridors' which ran north of the Himalayas and the Kuen Lun Mountains. These routes entered China from the north-west into the Yellow River basin—a very important cultural factor, as we shall see later.

The controlling factor in the climate of China (to quote Bishop[28]) is the alternating occurrence of the monsoon winds. The summer monsoon, blowing steadily from the south, is warm and moist, the winter monsoon, from the north-west, is cold and dry, and the year is divided sharply into a hot humid summer and a cold dry winter. China in fact has one of the worst possible climates for its latitudes, a climate that makes for great lethargy during many months of the year.

The Neolithic period in northern China was much poorer than in the Occident, for it had neither the ox, sheep, nor goat in its early phases, and trade was little developed. Of the Neolithic period in western or southern China we as yet know little, for not a great deal of archæological work has been done there. Bishop (pages 12 and 13) assumes that the beginnings of the Bronze Age, together with the herding of sheep, came to China from the west *three thousand years* after its origin in the Near East (4500 B.C.). China was in fact, with Japan and the British Isles, the last area of the old world to enter the Bronze Age and the last to leave it.

Thus the first important steps in civilization in China did not, as far as we at present know, originate along the humid southern coast, but were introduced in the northern Yellow River area. The recent historical parallel to this is obvious, for in America the local development of the Iron Age came not from earlier native civilizations, but by importation over sea routes from Europe.

Around 1600 or 1500 B.C. authentic Chinese history may be said to begin, with the Shang dynasty ruling the middle and lower Yellow River area from south-western Shansi. Most of the Chinese at this period dwelt in round pit dwellings, but the ruling classes lived in well-built, large rectangular timbered houses, with roofs supported by rows of wooden pillars with stone or bronze bases—a type which has survived down to the present time, and which recalls the megaron house of ancient

[28] Carl Whiting Bishop, *Origin of Far Eastern Civilization*, 1942.

Greece. The Shangs in fact developed a fine architecture, considering they had the use of neither dressed stone, brick, nor iron; and bronze working was brought to a pitch of technical and æsthetic excellence. Clothing too improved rapidly under the Shangs, and both hemp and silk were woven into cloth. Writing also was developed. Thus it can be said that by 1200 B.C. northern China, though still a thousand years or more behind the Near East, had developed architecture and clothing to a degree, but had achieved no great mastery over fire.

The Shang Empire fell about 1100 B.C., not to tribes from the south, but to the Chóus to the north-west, that is, to tribes nearer along the steppe corridors to the Near East. Their civilization, says Bishop (page 23), appears to have had a closer resemblance to the Near East than to the Shangs—particularly in the possession of a superior weapon, the bronze sword. The Chóus themselves were being pushed from behind, the historical parallels of which may be found in the history of eastern Europe.

The Chóus of 1050 B.C. had established a much larger empire than the Shangs and covered about half of present-day China, down to and past the Yangtze basin, but by 800 B.C. the Chóu line was driven eastward by renewed attacks from the west.

Meanwhile in the Near East mounted troops and iron weapons had appeared about 1200 B.C., and by 770 B.C. the western 'barbarians,' who expelled the Chóus and drove them eastward, were armed and mounted in this manner. It had taken 500 years for the new developments to reach China. At the same time Japan was acquiring the Bronze Age from China. Japan, like Britain, was then the most backward area of all.

About 200 B.C. the Han dynasty came into being, and with it the spread of Confucianism and the Iron Age. In both the Yellow River and the Yangtze River areas iron supplanted bronze only very slowly, being used, as in Homeric Greece, more for domestic utensils than for weapons. 'Superior iron ore and abundant wood for charcoal encouraged production of steel in the Yangtze Valley,' says Bishop (p. 46), 'but in northern China, where wood was scarcer, coal came to be used in the reduction and manufacture of iron.'

About the close of the third century B.C. there arose the

house of Ts'in, which had previously acquired control of the eastern termini of both the two transcontinental routes linking the Occident with China. The Ts'in rapidly established a real Chinese Empire, which continued until about A.D. 200.

Thus up to the birth of Christ the great outstanding facts in the history of China are, first, that it had one of the most extreme climates in the world, from hot moist summers to cold dry winters, and had developed no means of climate control through the use of fire; secondly, that all progress came along the routes from the Near East, often taking several centuries over the journey for each development; and that, thirdly, northwest China, which was the receiving area of advance, also acted as a cultural diffusion centre for the rest of China, spreading first the Bronze Age and then the Iron Age to southern China, Korea, and western Japan. In eastern Japan there was a direct transition from the Stone Age to the Iron Age.

The history of China in modern times is somewhat comparable to that sketched above; it is a record of invasions, adaptations, empires, and anarchies. Out of it all comes the priceless heritage of Chinese art. But now the main centre of power is on or near the coast. In the year 900 Peking becomes the capital city for the first time, and Kublai Khan, under whom 'never was the nation more illustrious,' chose Peking as his capital when he became Emperor in 1280.

It is worth while in this connection to quote Marco Polo, who visited China for an unexpectedly prolonged stay a few years later. In Chapter XXX of his *Travels,* which is headed 'Concerning the Black Stones that are dug in Cathay and which are burnt for Fuel,' he says:

> All over the country of Cathay there is a kind of black stones existing in beds in the mountains, which they dig out and burn like firewood. If you supply the fire with them at night, and see that they are well kindled, you will find them still alight in the morning; and they make such capital fuel that no other is used throughout the country. It is true they have plenty of wood also, but they do not burn it, because those stones burn better and cost less. Moreover, with that vast number of people, and the number of hot baths they maintain—for every one has such a bath at least three times a week, and in winter if possible every day, whilst every nobleman and man of wealth has a private bath for his own use—the wood would not suffice for the purpose.

Marco Polo thought the city of Kinsay (Hang-Chau), the metropolis of Central China, 'beyond dispute the finest and noblest in the world, and which hath a hundred miles compass.' 'You must also know,' he continues, 'that the city of Kinsay has some 3,000 baths, the water of which is supplied by springs. They are hot baths, and the people take great delight in them, frequenting them several times a month, for they are very cleanly in their persons.'

There is little more we can gather of the heating systems of the Chinese at this period. Whether they used stoves (as appears probable), or the hearth, or the brazier is not too clear, but we do know that in China coal was a common fuel in A.D. 1290. Up to the time of Christ, as Bishop points out, China was one of the most backward areas of the earth. Thirteen centuries later it has a civilization not unworthy to be compared with that of the Roman Empire in many ways, for it had a remarkable system of roads, couriers, paper money, town-planning schemes, baths, and spectacular buildings. A century later, by 1368, Chu Yüen-chang, founder of the Ming dynasty, changed the site of the capital to Nanking, but Peking became the capital again in 1421. In 1616 the Manchu Tartars made Mukden, the furthest north yet, capital of the Empire.

Throughout all the period, while China made considerable advances in pottery and art, generally speaking her culture was in the main considerably behind that of western Asia or Europe. But despite the great works of Carl Bishop, Creel, and others, the social history of China still has to be written, and we know so little of Chinese heating methods that it is impossible to give her cultural development in any detail. But we do know that China, in spite of her teeming millions, was for many ages one of the most backward nations of the world, and her history brings out the point that in the days before man could build and warm a house with any skill, civilization originated and continued along the 70° annual isotherm, or equivalent areas, but only if those areas had relatively mild winters and dry summers. Where climatic conditions were severe, life continued to be nasty, brutish, and short.

VI

THE COAL CIVILIZATIONS

We have seen in the previous chapter that, apart from the Greek and Roman civilizations, every civilization up to the thirteenth century was centred in an area not far removed from the 70° F. annual isotherm. The only exceptions appear to be civilizations like the Inca and Aztecs, which were in mountainous areas well in the tropics. How much should be allowed for the fierce effect of tropical sunshine, it is difficult to say. With the thirteenth century, however, some four or five developments had taken place which changed the face of the world, and removed the focal centres of civilization from the 70° F. isotherm area to countries much cooler.

As early as the eleventh century there had appeared the first significant change in climate control in a colder zone. Up to an indefinable point in history, all non-Roman fortifications in north-west Europe had been of earth or of single-storey buildings, mostly of wood. But somewhere about A.D. 1000 the Normans had developed the technique of building high rectangular towers of masonry. They conquered England about 1070, 'a place of heavy, foolish men with random laws, pale eyes, and a slow manner; their houses were made of wood: sometimes they built, painfully and childishly, with stone. There was no height, there was no dignity, there was no sense of permanence . . .' The Normans provided what was lacking.

In 1071 they built the Castle at Oxford; in 1075, Monkswearmouth Castle, Jarrow; and in 1077 castles at Rochester and St. Albans. In the next thirty years hundreds of castles, churches, and even stately houses sprang up. They had nothing but the last ruins of Rome to inspire them in design, they knew nothing of hypocausts, but they had to face the problem of how to have a fire in the lower rooms of a castle without the higher rooms becoming uninhabitable through smoke. The problem was met by transferring the hearth from the centre of

the room to the side, and carrying a broad flue through the wall some 10 or 15 feet above the hearth. At Rochester, Colchester, Conisborough, and Headingham there are still to be seen such elementary smoke shafts, and at Bodiam an interior shaft warms my lady's chamber above, but the date of this is uncertain.

These architectural changes, fascinating as they still are, were not, however, of the importance of those which followed about two centuries later, and early in the thirteenth century many significant changes in arts and appliances were helping to mould the future—the rediscovery of brick-making, window glass-making, and coal, and the invention of the fire-grate and the chimney. About this time the art of brick-making had been discovered afresh in Flanders, and gradually the use of bricks and tiles spread until it became general in many parts of Europe. The oldest brick house in England, Little Wenham Hall in Suffolk, dates from the thirteenth century. Simultaneously the glazed window became common among the wealthy, a further means of controlling cold and damp.[1]

Prior to this brick and tile period, the hearth was in the centre of the room, and a hole in the roof let out the smoke. Obviously, with walls made of wood and dried clay the fire could not very well have been anywhere else, but with the central hearth and the roof lantern to let out the smoke most of the heat generated by the wood fires of the period would escape—and only the wealthiest could afford continual fires.

The leader of this change in fashion was Henry III, who in 1236 married Eleanor of Provence. Possibly under the influence of his wife he became very keen to have warm, draught-proof rooms, and in the Latin Liberate Rolls of the period we find an illuminating succession of royal orders directing improvements in the King's castles that were scattered throughout the land.

As early as 2 March 1238, we find the King ordering the Sheriff of London 'to complete the chimney[2] of our Queen's

[1] Glass was known and used in Egypt in 1740 B.C., but the earliest windows in north-west Europe are those in the church of Saint-Denis, France, twelfth century. The Saxons were fine glass-makers, but I have found no evidence of their using glass for windows.

[2] The Latin words *fuminar* or *fumerium* might be translated as fireplace, for where there is a flue to be built as well this is often separately mentioned.

chamber in our tower of London,' and on 27 December of the same year, Walter de Burgh is ordered 'to make a chimney in the Queen's great lower plastered chamber at Brill,' and 'to wainscote as well the upper as the lower chapel of the Queen at Kennington and to raise the flue of the King's chimney there.' From that date onwards until 1270 there is a steady stream of orders to sheriffs and court officials in almost every county from Kent to Hereford and northwards to Northamptonshire and Nottinghamshire. Nearly all these orders point to a mind imbued with the idea of securing warmth and dryness. Windows were to be glazed, or even reglazed, and sometimes enlarged, porches were to be built to external doors, passages or covered ways to be made from one building to another, walls and roofs were to be wainscotted, lavatories were to be built next to the Queen's chamber and a drainage scheme installed. Above all, fireplaces and chimneys were to be built and rooms to be painted 'green spangled with golden stars.'

In one of the last orders (1268) the sheriff of Wiltshire is ordered 'to pull down the long house beside the great gateway of the Manor of Clarendon and to build in its stead a chamber with a chimney, and an outer chamber for the use of the King's esquires . . . a chimney in the chamber over the King's cellar, to put two large windows in the chamber of Alexander.' And the 'Sheriff of Surrey and Sussex is commanded to build within the courtyard of the King's manor of Guildford a certain chamber with an upper story, and a chimney, wardrobe and an outer chamber, . . . and a chamber with an upper story and chimney, outer chamber, and glass windows, befitting the same chamber for the use of the Knight of the King's consort Queen of England; to make a new penthouse there, and to repair and improve the Queen's "harbour" there as the King enjoined unto William Florentyn, his painter.'[3]

It is significant that most of the artists or artisans mentioned in these orders have French or Italian names, which leads one to suspect that the arts of glazing, chimney making, and wainscotting were of Provençal or Italian origin. Certainly Henry III spent a great deal of money on these 'foreign favourites,' to the annoyance of his Norman and English barons, who finally in 1264 had their way and under Simon de Montfort's leader-

[3] T. Hudson Turner, *Domestic Architecture*, vol. i.

ship forced the King off the throne, and scorned his improvements.

Although Henry III and his warmth-loving Queen may appear to be very advanced for their time, contemporary judgment was against them; even Dante relegated him to the limbo of ineffectual souls.

In any event it was a century or two before these heating innovations spread and England became a land of warm, dry houses.

It may be well, perhaps, to endeavour to imagine the conditions under which people in this country tried to work and think prior to the development of the 'sealed' house. The people of Britain numbered then (in 1400) about 2½ millions—and they lived for the greater part in buildings that would compare with the wooden farm-barn of to-day. When the Romans left, their towns and superb central-heated villas were sacked or neglected, and the Britons, Saxons, and Angles made wooden or wattle huts thatched with straw, reeds, heather, or whatever was handy—clay or mud being used to stop the gaps. Glazed windows and coal were unknown. We read that even Alfred the Great, who twice visited Rome, and was determined to raise the level of his people, found that when he came to work by candlelight 'the draught that blew in through the door and windows, through the chinks in the walls, or through the slits of tents, made the candles burn unevenly.'[4] The Norman barons were, as we have seen, a little better off in their castles, but the average dwelling remained the same for centuries. A countryman's house even as late as the time of Queen Elizabeth is thus described:

> Of one bay's breadth [16 feet] God wot, a silly cote,
> Whose thatched spars are furred with sluttish soote
> A whole inch thick, shining like blackamoor's brows
> Through smoke that down the headless barrel blows.

But with bricks and mortar there came the significant acceptance of the fireplace and the chimney, and shortly afterwards that of the grate and the use of coal.

It was these three innovations, the chimney, the grate, and the use of coal, combined with new developments in architec-

[4] Williams, Ellis, and Fisher, *History of English Life*, p. 92.

ture, which changed the whole history of mankind. Unfortunately, history is almost silent on the origin of the chimney and the grate. Possibly the earliest chimney-piece known in the world is in the King's House at Southampton, which is attributed to the twelfth century,[5] but another Norman house, at Boothby Pagnell, Lincs, disputes the honour, whilst at Abingdon Abbey, Berks (*circa* A.D. 1250), Aydon Castle, Northumberland (*circa* A.D. 1280), and Sherborne Abbey (*circa* 1300) there are other chimneys quite modern in appearance to which the glory of being the first might possibly be given. None of Henry III's castles remain in good condition to-day.

Wood and charcoal were still the common fuels for the large open fires of this transition period, and for the support of the burning logs iron bars, or andirons, were employed; these, by raising the wood from the hearth, allowed a freer circulation of air around it, and so occasioned an accelerated combustion. The hearths were wide, with massive beams of wood to support the heavy canopies and in their deep recesses great fires were built up, around which the lords and their retainers could gather.

Let us now see how the Renaissance, or the 'revival of learning,' is related to this. It took its rise in France and northern Italy in the thirteenth century and it is noteworthy that the first great Englishman of the New Learning was Roger Bacon (1214-94), who spent sixteen of the most formative years of his life at Paris. The philosophic questioning of the thirteenth century was followed by the study of the great classical writers whose works now became available through the collapse of the Byzantine Empire. It is interesting to note that the Renaissance was preceded or accompanied by the development of the fireplace and chimney, especially in northern Italy. A Florentine document, *Cronichetta di Memorie famigliare di Neri degli Strinati,* refers to a fireplace built in the thickness of a wall in Pisa in 1300, and there is also mention of a similar construction two years later. The chronicler, Giovanni Musso, writing of Piacenza, affirms that before 1320 chimneys did not exist in this city: '. . . there was then no chimney in houses because

[5] It is interesting to note that the first time the word chimney is used in the English language is in the decade 1330-40, when it was used to denote a fireplace or hearth, or a 'turret flue.' See *Oxford English Dictionary.*

then they made only a fire in the middle of the house, under the dome of the roof, and all of the said house stood around the said fire, and there the cooking was done.' His later chronicles, however, describing the same city in 1388, mention that chimneys had, during the intervening years, been built in many houses.

It was in Lombardy and Tuscany that the more rapid development took place, as in those two States fireplaces came into more general use, not being restricted to the houses of the nobles. In 1364, in Florence, a fireplace was constructed in the refectory of the Ospedale di Gesu Pelegrino.[6] In 1368 Francesco da Carrara, a Paduan prince, 'on making a journey to Rome took with him masons who constructed a chimney in the inn at which he stayed because in Rome they did not then use chimneys and all lighted the fire in the middle of the house on the floor.' This statement is borne out by the fact that by the middle of the fourteenth century in Florence fireplaces began to be built in all rooms instead of a single fire for the whole house. The Palace d'Avanzati (*c.* 1350) is a notable example.

Further proof of the general use of chimneys in northern Italy can be found in Dr. Margaret Fishenden's *House Heating,* where she says (page 14 et seq.):

> Their use was frequent in Italy in the fourteenth century, for an inscription found in Venice states that in 1374 a number of chimneys were overthrown in an earthquake. Some doubt attaches to the exact meaning associated with the early use of the word, which was probably synonymous with 'hearth' or 'fire-place.' Flues carried right up the walls of the house appeared later; the earlier ones were generally circular in section and consisted of a single flue with smoke apertures in the side of the summit or louvre. During the fourteenth century ornamented chimneys appeared, the chimney and the shaft itself frequently being treated as the important architectural features.

Thus, by the beginning of the fifteenth century fireplaces had become common in northern Italy, and during this century the multiplication of the fireplaces led to the grouping of several flues inside a vertical and generally rectangular mass of masonry carried well above the roof. In Italy these chimneys were utilitarian and were hidden whenever possible. The fireplaces and mantelpieces, however, were lavishly decorated.

[6] Turner, *Domestic Architecture,* 1851, *Introduction,* p. 17. See also Erik Lundberg, *Öppna Spisar,* 1940.

It is, perhaps, only another coincidence that the greatest improvements in heating and warming methods since Roman times should have originated in an area which, within a comparatively short time from the date of their general adoption, gave birth to the Renaissance.

This great outburst of civilizing thought received a powerful stimulus from the fall of Constantinople in 1453, which caused the dispersion of Greek scholars from Byzantium, carrying their manuscripts with them. But a hundred years earlier than this there had begun that thirst for the new learning in northern Italy which rendered so popular the lectures of Emanuel Chrysoloras, who had come over from Byzantium in 1396 and was soon followed by others, greatly encouraged by Cosimo de' Medici (1389-1464).

This blaze of art and learning soon spread to the neighbouring lands, as did the twin developments of the fireplace and the chimney; but countries to the north and west had this advantage over northern Italy, that where she could only control her winter climate, Germany, Switzerland, Holland, France, and England could control indoor temperatures throughout the winter, spring, and autumn. By 1500 the Netherlands and the adjacent territories were the richest and most urbanized areas of Europe. Antwerp, indeed, could now be regarded as the hub of civilization. Erasmus, Holbein, Dürer, the Van Eycks, Memling, Grotius, Grocyn, Linacre, More, Colet, Ascham, and Camden, and scores of other great humanists, testify to the great advance that civilization made in this area during this period, and they were rapidly succeeded by Marot, Montaigne, Rubens, Van Dyck, Bacon, Shakespeare, and Marlowe, and others whose fame has echoed round the world.

In this great upsurge that now began, Britain, though its climate is so cold and damp as to be a byword for inhospitality, had one advantage which was eventually to give her the lead over many rivals apparently more favourably placed—the possession of illimitable supplies of coal fuel.

When we consider that coal is to be found in every continent of the world, and particularly in Britain, Germany, France, Belgium, the Netherlands, Poland, Czechoslovakia, Russia, India, Japan, South Africa, the United States, and Australia, each of which countries now produces over ten million tons

a year, it is remarkable that its utility for so many purposes was neglected until this period. Theophrastus in 200 B.C. knew of coal in Liguria and in Elis, where it was used by smiths; but the first documentary evidence of acquaintance with coal in England is found in A.D. 853, in the Saxon Chronicle of the Abbey of Peterborough, though many believe this fuel to be brushwood or peat. Cinders are also frequently met with among Roman remains in this country, but these were undoubtedly from forges and not from domestic use.[7]

After 1200 outcrop 'mining' was carried out, and by about the middle of the thirteenth century coal may be regarded as having become a commercial product. For a century or two the domestic use of coal was restricted to burning with wood, as at Jarrow monastery from 1313 onwards; it was not used alone on account of its smouldering tendencies on the hearth fire, and because of its unpleasant odour.[8] It is easy to see that without adequate draught not only would the coal not burn well, but that the resultant smokiness must have been most unpleasant.

As early as 1273 the burning of 'sea cole' was prohibited in London because of its smoke, and in 1306 a citizen was executed for contravention of this law, but the eventual development of fire-grate and chimney-shaft removed the objectionable smell, and by 1540 coal-burning, draught-proof houses, with windows instead of slits, were generally adopted throughout the middle and upper classes in England, in spite of petitions to Parliament that the importation of coals into London from Newcastle should be prohibited.[9]

Parliament, however, could not stop the consumption of coal, and by 1546 we find Henry VIII ordering 3,000 chaldrons for use in France, and in 1577 Harrison's *Description of England,* a prefix to Holinshed's *Chronicles,* records that 'coal mines are so plentiful in the north and west of England as to supply the whole of England with fuel. The use of coal has

[7] It is recorded in Collingwood Bruce's *Hadrian's Wall* (1933 edition) that when the Roman fort at Housesteads, near Hexham, in Northumberland, was excavated by Mr. Clayton in the middle of last century 'nearly a cartload of coals' were discovered in one of the turrets there. This coal is believed to have been obtained from an outcrop near by.

[8] Archer, *History of the Coal Trade,* 1897.

[9] As late as the seventeenth century we find the City of London petitioning Parliament to suppress the 'anusance of Newcastle coals in regard to their stench.'

grown from the forge into the kitchen and hall, and is a check to the waste of wood burning.' The price was then about five shillings a ton at Newcastle.

This new method of heating proved so popular in England that by this time almost every village had chimneys. William Harrison, the clergyman noted above, writing in his delightful *Description of England,* speaks of the great progress of the period. 'Old men yet dwelling in the village where I remain,' he says, 'find things "marvellously" altered within their sound remembrance, . . . one is the multitude of chimneys lately erected in each village, whereas in their young daies there were not above two or three but each one made his fire against a reredos in the hall.' The 'sealed' house, with its glazed windows, fireplace, and chimney, had come to stay.

At the same time there was a parallel development in clothing. The arts of spinning and weaving date from pre-historic times, with wool as one of the earliest textile fibres. In Britain, under Roman tuition, these arts were improved considerably, especially at Winchester. From the time of William the Conqueror, Flemish weavers were imported to improve the native skill, especially under Edward III (1327-77); local improvements in these arts were such that the King himself wore British cloth. Woollen *clothes* were introduced into England in 1191, and in 1390 were made at Kendal. Their use became general within a few decades. Linen, an Egyptian discovery, was first made in England in 1253, and rapidly became popular with the ladies. All these developments were great aids in resisting the rigours of the northern climate, and even today our first line of defence against inclement weather is clothing, which in its widest interpretation includes blankets and sheets.

Meanwhile on the Continent there was developing the stove, a German or Danish device which originated in the fifteenth century. Around 1521 Martin Luther enjoyed the warmth of stoves in his rooms in Wartburg Castle. In 1562 Bullein in his *Bulwark Book of Sick Men* makes the earliest reference in English to the stove, which he describes as 'a fyer of charcoales, or a stove, which is fyer secret felt but not seene.' (p. 6)

In 1587 William Harrison wrote, 'as for stooves we have not hitherto used them greatlie, yet do they begin to be made in diverse houses of the gentrie, who build them not to work or

feed, as in Germanie and elsewhere, but now and then to sweat in.' Throughout northern Europe the use of the stove spread rapidly about this period, the major fuel being wood, until about 1600 when Newcastle coals were freely exported to Europe. The production of coal at Newcastle increased from 190,000 tons in 1602 to over 1,000,000 tons in 1650. Gray in his *Chorographia of Newcastle upon Tyne* (1649) relates that

> coal in great abundance is carried into most parts of England southwards and into Germany and other transmarine countries. Many thousand people employed, which trade of coal began not fourscore years since. Coales in former times was only used by smiths and for burning of lime; woods in the south part of England decaying, and the City of London and other cities and towns growing populous, made the trade for coale increase yearely, and many great ships of burthen built in one year than was in seven yeares forty yeares by-past; this great trade hath made this part to flourish in all trades.

The deep fundamental importance of this change is so remarkable that it cannot be over-stressed. The nations of northwest Europe now had the means of mitigating the severity of their winters. No longer was man's energy during the long winter months absorbed in resisting climatic extremes, for the warm comfort within doors gave them conditions almost as good as their southern neighbours were enjoying out of doors.

Britain with her re-discovery of coal and her vast coal deposits now began to lead the way in this new indoor civilization, but the Netherlands, northern France, and Germany were swift to follow where they had previously led. Neither Spain nor Portugal, Venice nor Genoa, could resist the advance, for in accordance with the great fundamental law already indicated, civilization has a greater chance of developing where the climate, indoors and out of doors, is most suitable for man's activity. The vital point is this: men could now control cold and damp, for as the coal fire, in an iron grate and with a proper chimney, warmed the air, it dried it in a way that the hearth fire with the roof lantern could never do. To give an indication of what this means let us take an average January and July in London. January's average outdoor temperature is about 38° F. and the relative humidity about 80 per cent, but indoors the figures are about 65° and 50 per cent wherever effective heating methods are used. In fact it may be

said that indoor conditions in January in England are better for mental work than outdoor conditions in July and August. Control over dampness is as effective as control over cold. But man was still unable to control heat or dryness. The burning days of a Spanish or Italian summer could not be modified as could the cold damp days of northern Europe, and as north-west Europe throve, Spain and Italy began to decay.

Gradual modifications in the design of the domestic fireplace accompanied the constantly increasing use of coal, for the burning of which the large open hearths and irons of the old wood fires were found totally unsuited; but owing to the lack of transport facilities, wood still remained the common fuel in rural districts, and in 1800 the total consumption of coal of the kingdom for all purposes was still under 11 million tons. The latter half of the nineteenth century, however, saw a remarkable development of canal navigation, and coal soon began to find its way into new districts and rapidly became the general household fuel of the nation. By 1869 the total home consumption of the United Kingdom had risen to over 65 million tons, of which no less than 18½ million tons were absorbed for domestic use, and over 6 million tons by gasworks.[10] In 1913 the total consumption figure was 189 million tons, probably about 36 million tons of this being burned in the raw state in domestic grates, and 18 million tons utilized by the gasworks. In 1938 total British production was 227,000,000 tons of which 36,000,000 tons were burned in domestic grates, and 36,000,000 tons exported.

These figures reveal the astonishing fact that of the entire coal consumption for all purposes, including factories, iron and steel industries, mines, railways, and gasworks, about 19 per cent is absorbed in its raw state for the warming of our houses, and almost invariably also for the polluting of our atmosphere, and the defacing and destruction of the building materials, decorations, and fabrics with which the smoke comes into contact; yet the problem of successfully and economically warming buildings is, as a science, still only in its infancy.

Gradually this coal civilization spread, aided after 1800 by gas lighting and heating, and after 1830 by kerosene, steam heating and hot-water systems. The stove and the furnace

[10] 'Report of First Royal Coal Commission,' 1871.

added to man's control of cold and damp. In every art and science, in every field of exploration and discovery, north-west Europe now made vast strides. The Industrial Revolution was one of the striking developments of this period. Coal made power. Moreover, the mental energy required to develop industrial power and machinery was assisted through indoor climate control which permitted all the year round application to difficult problems.

Europe had the mastery over all the continents, and the white man bestrode the world like a Colossus. He imposed his will on Asia and Africa; he planted his settlements and colonies in the most favoured parts of the earth; and where he could not settle he seized control of the mineral wealth and raw materials. Great Britain and France profited greatly by these new conditions.

The development of North America was an equally important result. Here for countless centuries had been some of the most fertile land in the world, but, save along the Pacific coast, its exploitation had been checked by the grave drawback of climatic extremes. At Chicago, the Red Indian predecessor of the modern American had to contend with temperatures that fluctuated from a monthly mean of 24° F. or less in winter, to 73° F. in the summer; yet Chicago was one of the more fortunate areas since it lay on the shores of a vast lake which modified extremes. At St. Paul, Minnesota, the range was still greater—from 12° to 72°, and in the heart of the land, away from the Great Lakes, from Winnipeg to Nebraska, and from Salt Lake City to St. Paul, Minnesota, the monthly range was over 60° from winter to summer, from well below freezing-point to a heat that was almost unendurable.

Into this land poured the energetic men and women of the coal civilizations, British, French, Dutch, German, and Swedish. Some went north to what is now New England and Canada, others south to New Orleans or Charleston. They had equal chances. Yet in the south, where the heat of the summer was well above the ideal maximum, their civilization seemed static. Not only here, but in the West Indies, in South Africa, in every warmer zone where these multitudes of Europeans settled, the 'poor white' problem appeared. In the colder zones, on the other hand, such as New England and the Great Lakes

area, and in those portions of the American continent where the climatic range is small and approximates to the ideal, as along the Pacific coast, European civilization took on a new life, a new energy.

All over the world this stream of European emigration spread, bringing with it the habits of the well-built house, the coal fire, and oil or gas lighting.[11] Wherever this stream reached the warmer lands it lost its vigour. In India and the Sudan the British found that only by frequent periods of leave, and by constantly replacing their soldiers, administrators, and officials, could they retain their hold. The whites could overrun the world, but they could not people the world. Whenever this coal civilization came into conflict with peoples of a warmer area, it gained decisive victories. The British acquisition of India, the European conquest and partition of Africa, the wars between the United States and Mexico or Spain, all tell the same story: victory was ever to those peoples whose home was in a climate that could be controlled.

In the last two centuries nothing has been more spectacular than the rise of the United States and the decline of Spain. In 1776, when the United States came into existence as a distinct nation, Spain could boast the largest empire the world had known. Her dominions stretched from Louisiana to Chile, and included the Philippines, Cuba, Haiti, and a score of smaller colonies. But we have already seen that while other nations were increasing in numbers and adopting methods of climate control, Spain had a stationary population and, perhaps most important of all, failed to develop climate control to any considerable extent.

By contrast the United States advanced rapidly both in population and in climate control. In 1790 her total population was under 4,000,000, by 1898 it was over 71,000,000; whereas Spain had only increased her population from 10,500,000 to 18,000,000 in the same period, and had already lost the greater part of her American empire. Thus when Spain and the United States met in war in 1898 it is not surprising that the former was decisively defeated in only sixteen weeks.

[11] Electricity for lighting and heating may be dated from Green and Staite's first patent for electric light in 1846, but it was another half-century before its use became general.

Part of the United States' great accession of strength was due to immigration, but the gain of the United States was the loss of other countries. It has been estimated that in the nineteenth century the United States received no less than 50,000,000 immigrants.[12] The American 'Homestead' Law of 1862, which gave 160 acres to every immigrant citizen-head of a family, acted like a forced draught to a furnace already burning well. In the next 40 years 14,000,000 (mostly British and German) migrated from Europe to the United States, and over 2,000,000 to Canada, of whom many crossed the border and became United States citizens. From 1850 to 1913 no fewer than 18,000,000 people left the British Isles to take up a permanent residence in North America. Prior to this great wave there had been 1,000,000 paupers in England (1842), and in Ireland famine 'stalked like a spectre through the land' as a result of the failures of the potato crops during the years 1845-47. When crops failed, rents failed, and when rents failed, landlords evicted tenants, to emigrate or to die: they died in their thousands, but they emigrated by tens of thousands. History may be searched in vain for a parallel to so extraordinary an exodus of the human race in so short a time. From 1846 to 1855 over 1,812,000 Irish men and women emigrated. From 1842 to 1895 the population of Ireland, despite a birth-rate of 26 per 1,000, decreased from 8,300,000 to 4,600,000.

A similar movement, but on a smaller scale, occurred in Germany and other European countries during the latter half of the nineteenth century and the opening decade of the twentieth century; the stream of emigration began with the crushing of the revolution of 1848. In the next 20 years 1,380,000 Germans emigrated to the United States, a movement which only slackened when the vigorous economic policy of the new German Empire showed its people how to live at home. Italy, Austria-Hungary, and Russia, in the decade immediately preceding the War of 1914-18, each sent over a quarter of a million emigrants *yearly* to the United States.

But this great stream was dammed early in the twentieth century. Immigration practically ceased with the War of 1914-18, for in 1921 the United States closed her doors to unrestricted immigration, and other countries (notably the British

[12] Rossiter, *A Century of Population Growth*, 1909.

Dominions) followed suit. In some of these countries, such as New Zealand, the depression of 1930-32 caused a reversal of the tide of immigration.

It is interesting to consider of what type these emigrants were. The generally accepted view is that they were of the best and most adventurous stocks, but some of those who migrated from Europe to America were men who, in their own country, had fallen behind in the race. The Irish farmer or English artisan who emigrated often represented the less successful type of his own class, and those who moved on again to the 'frontier' were those who had not met with much success in the region nearer to the Atlantic. Few men who have won a good position by grit or skill desire to emigrate; those who cannot succeed in the struggle at home emigrate if they can. Natural selection, therefore, may sometimes be on the side of those who remain at home. 'A migration as a rule,' Huntington says, 'is merely a slow drifting of people with unusual energy and initiative from unfavourable to favourable districts.' Is it not sometimes a slow drifting of those below the standard of competition in their own country to countries where the competition is thought to be less fierce? Again, the successful emigrant occasionally returns to his own country, the unsuccessful rarely does so.

But whilst emigration has, therefore, been a powerful factor in building up the numerical strength of the United States, the British Dominions, and the Argentine during the last century, it is rapidly declining as a nation-building force.

Birth-control has replaced emigration as the means of limiting population in a restricted area; indeed it may now be urged that it is far more effective, and in several countries of north-western Europe the birth-rate is so low that it is extremely doubtful if present populations can be maintained. In France, Esthonia, Sweden, Belgium, Austria, Lithuania, Switzerland, and the United Kingdom the rate of natural increase (i.e. excess of births over deaths) is now less than 5 per 1,000 per annum. Fertility rates have halved, and the number of potential mothers is fewer than 20 years ago. This is also true of other countries in which the urban industrial civilization of modern times has been highly developed. There is also a falling tendency in countries less highly industrialized.

Thus pressure of increasing numbers as a factor in national economy no longer operates in the following countries:

	Population 1939 *in thousands*	*Excess of Births over Deaths per* 1,000 *population per annum* 1921-30	1931-35
France	42,014	1.75	0.8
Austria	7,009	4.8	0.9
Esthonia	1,134	2.6	1.6
Sweden	6,310	5.4	2.5
United Kingdom	47,478	6.45	3.3
Belgium	8,386	5.95	4.0
Latvia	1,950	6.6	4.4
Switzerland	4,218	6.25	4.6

France, owing to her relatively high death-rate compared with that of other civilized countries, actually registered decreases in 1929 and 1935, while Austria and Esthonia have each recorded a decrease for one year.

In France, Austria, and Esthonia, therefore, unless there is a drastic upswing in the birth-rate or an equally surprising fall in the death-rate, we can expect to see a declining population in the near future, and those countries will tend to count less and less among the forces of civilization because of their non-expanding numbers. They are dropping behind through sheer lack of 'punching power.' But whilst these countries have populations which are almost stationary, others are increasing rapidly in population, notably the following:

	Population 1939 *in thousands*	*Excess of Births over Deaths per* 1,000 *population per annum* 1921-30	1931-35
Palestine	1,466	22.0	23.7
Guatemala	3,044	23.1	19.6
Salvador	1,704	21.4	18.0
Mexico	19,478	8.8	17.7
Philippines	13,000	15.6	17.3
Ceylon	5,312	13.4	15.9
Egypt	15,904	17.9	15.7
Argentine	13,130	17.5	15.2
Colombia	8,701	14.4	15.2
Yugoslavia	16,200	14.2	14.0
Bulgaria	6,549	16.7	13.8
Japan	72,222	13.5	13.7
U.S.S.R.	192,695	21.0 *	No figures

* 1923-25.

Particular attention must be directed to Japan and Russia, whose existing population and rates of increase are bound to make them yet more formidable as national units. The Japanese growth from 33,000,000 in 1872 to 72,000,000 in 1939 was accompanied by the development and indeed by the adoption of those climatic controls which had done so much for north-west Europe and North America. Up to 1890 the paper-walled house was universal. The *Encyclopædia Britannica* of 1911 (vol. 15, p. 166) states, as an example of the quality of endurance possessed by the Japanese, that

> The average Japanese may be said to live without artificial heat; his paper doors admit the light but do not exclude the cold. His brazier barely suffices to warm his hands and his face. Equally is he a stranger to methods of artificial cooling. He takes the frost that winter inflicts and the fever that summer brings as unavoidable visitors.

Even as recently as in 1935 a keen Japanese observer could write:

> Most Japanese houses are not built of stone or brick like those in western countries. The principal building material is wood and bamboo. This is not due to the frequent occurrences of earthquakes, as many suppose, but to the peculiar climatic condition of this country.
>
> Much of the wall space of our houses is given up to 'shoji' or sliding paper doors that can be removed to let the air pass freely into the rooms to the enjoyment of the occupant. During the night wooden sliding doors are shut outside the 'shoji.' Usually the farm-houses are thatched with straw and are cool in summer and warm in winter. The straw-thatched roofs are fairly durable, and have to be renewed once in about thirty years. In every farm-house there is a fire-place, or hearth, called 'irori,' in which fire-wood is burnt for warmth, cooking and heating. The smoke rising up from the hearth permeates the roof material and kills injurious insects in it. Nowadays straw-thatched roofs are being replaced by those covered with zinc-plated iron materials, which being very light require smaller columns of wood to support them and are less expensive.[13]

But all this is changing rapidly, more solid structures are being built, and the coal grate or central heating finds its place in the architectural plan. Coal-mining, which began only as

[13] Takematsu Okada, *The Climate of Japan and its Influences on the Japanese People*, 1935.

late as 1890 when its technique had been learnt from the western nations, now supplies fuel in comparative abundance. And every decade up to 1940 saw Japanese trade, prestige, and military power improving. The result has been astounding. The defeat of Russia in 1904-5 was not only the victory of a maritime people over a continental people, but also the victory of a people from a mild climate over a people from a severe one. Her audacity in 1941 was further evidence of change.

But in this brief glance at world history one fact must not be overlooked, viz. that whilst comparatively few people may build up a civilization, it takes numbers to safeguard it. For just as Rome conquered Greece, and Germany overran Holland in 1940, so in all struggles between nations brute force is a factor of no slight importance, and among nations enjoying almost equal conditions of climate and climate control, the leadership will go to that which has the greatest numbers. In boxing terms: 'A good big 'un will always beat a good little 'un, but a good little 'un will always beat a poor big 'un.'

Throughout history it might be said that civilizations develop where a people enjoy for the moment the best natural climate and have the greatest control over it, but if they are numerically weak, their growing art and wealth will incite raid upon raid until at last they succumb to outside pressure. If they are numerous and united, then indeed they may lead the world, as nation after nation has proved, but if they are rent by internal dissension, whether due to religion, race, language, or dynastic reasons, then civilization will be checked; for so long as a people within a natural boundary are divided into separate political entities, so long will their maximum effort be retarded by rivalries and jealousies. The history of England and Scotland with its wasteful record of border feuds and invasions; the history of Italy with its intrigues and treacheries; the history of Scandinavia or Ireland with their consuming political dissensions, or of old Germany 'with its tangle of lilliputian and irrational princelings,' all bear out the retarding effect of disunion.

And yet the forces of language, religion, or race are so strong that few, if any, natural areas of the world have been united even during the course of the last two centuries. Belgium and

the Netherlands, Spain and Portugal, Norway and Sweden, and a dozen other areas bear this out.

In view of the importance of numbers to any nation, we must consider, not only present figures, but also the future trends of population. It is, perhaps, obvious that a country whose population is growing persistently decade after decade, whether through natural increase (i.e. excess of births over deaths) or from immigration, will tend to count more and more as a factor of importance in the world. Fortunately, in this respect we have perhaps the most accurate statistics possible for the greater part of the world, though there are striking gaps, as in respect of China and parts of Africa, where our information is of the scantiest kind. The League of Nations used annually to publish accurate statistics of population, including births and deaths for most countries of the world, and tables showing the natural increase.

It appears from the figures given a few pages earlier that the Asiatic countries, Egypt, and the Central American States are expanding yearly at the rate of about 18 per 1,000, while the north-west European races only at a rate of about 5 per 1,000. No figures are available for China or for the Negro races; even in South Africa no registration figures of natives are available in one province, but the increase of non-European races there during the decade 1911-21 was assessed at 15.16 per 1,000 per annum. Assuming, therefore, that China is breeding less rapidly than Japan and more rapidly than India, and that the Negro races are increasing at a rate somewhere between that of Egypt and that of the coloured races of South Africa, the conclusion is reached that *at the average existing rates* (1931-5) the population of the world will increase by some 250,000,000 during the next ten years, of whom 150,000,000 will be Asiatics.[14]

From the vital statistics of various countries we can get a good idea of the intense pressure of population in certain areas. The people of these countries, faced with the problem of se-

[14] Professor Charles Richet, President of the French Academy of Sciences, has estimated this increase to be 195,000,000 for the whole world and 140,000,000 for Asia. 'The Americas will grow by 35,000,000 and Europe by 20,000,000, others by little or nothing.' It is obvious that Africa will not remain stationary, and the estimate for Europe, including Russia, seems on the low side.

curing elementary conditions of life for their increasing millions, can do this:

(1) by bringing more of their existing land under cultivation, or starting successful new industries;
(2) by increasing the fertility of lands now cultivated, or improving industrial technique;
(3) by spreading into other lands.

Nature, in fact, says to these nations, improve, expand, or accept a lower standard of living. England, Ireland, Germany, Russia, and Poland were all faced by these problems during the last century, and their expansion (emigration) to America and other areas was the main solution. Japan is faced with it to-day, for its villages present almost the most densely populated countryside in the world. Every small patch of arable land is already used for rice, barley, wheat, or mulberry. The production of rice for many years increased at a quicker rate than the growth of population, but the limit has apparently now been reached, while forestry and fishing are static industries. The prospect for the next decade is, therefore, a serious one, which emigration to the mainland may ease slightly. Other lands have closed the door against Japanese immigration, and it is doubtful if more than 50,000 emigrants can be sent out in any year, either to South America or to China.

Agriculture, therefore, has reached its limits, expansion in terms of emigration is practically impossible: there remains industry. The expansion of industrial exports may provide her increasing millions with gainful occupations. At present between seven and eight millions are now employed in connection with Japan's foreign and colonial trade; if they can succeed in enlarging this trade, the greater part of the future increase in population can be absorbed. But international trade has been constricted by tariffs, quotas, and a hundred other products of economic nationalism. Japan has recently increased her share of the world's trade—but other countries in turn want foreign trade and resent the Japanese invasion of their markets—hence higher tariffs, greater restrictions. Is it the law of the jungle written in economic and diplomatic terms?

Mankind has shown amazing heroism in ensuring the continuance of the race—the Maori trek across the Pacific, the

Parsee emigration from Persia to India, the European emigration of the nineteenth century, all have been caused by pressure, intense pressure, at the heart of a nation. Expand, be energetic—or die! And nature's challenge is none the less a challenge because it comes in terms of trade treaties, industrial invention, or even the persistent thistle and other agricultural pests.

But history does not permit us to accept expanding numbers as the cause of civilization, for if so, countries such as India, China, and Russia would be in the van. Moreover, countries such as Greece 2,000 years ago and Great Britain 300 years ago had a relatively minute population when compared with their rivals.

Sheer pressure of numbers, therefore, may make a nation warlike and cunning, but something more is needed to make them civilized. The Goths and Visigoths overran Europe, but they left it less civilized than before their advent. The Turk, too, could expand and conquer, but left in his train the proverb, 'Grass will never grow where the Turk's horse has trod.' Numbers alone may give a nation military power, but they will not give it a great civilization.

VII

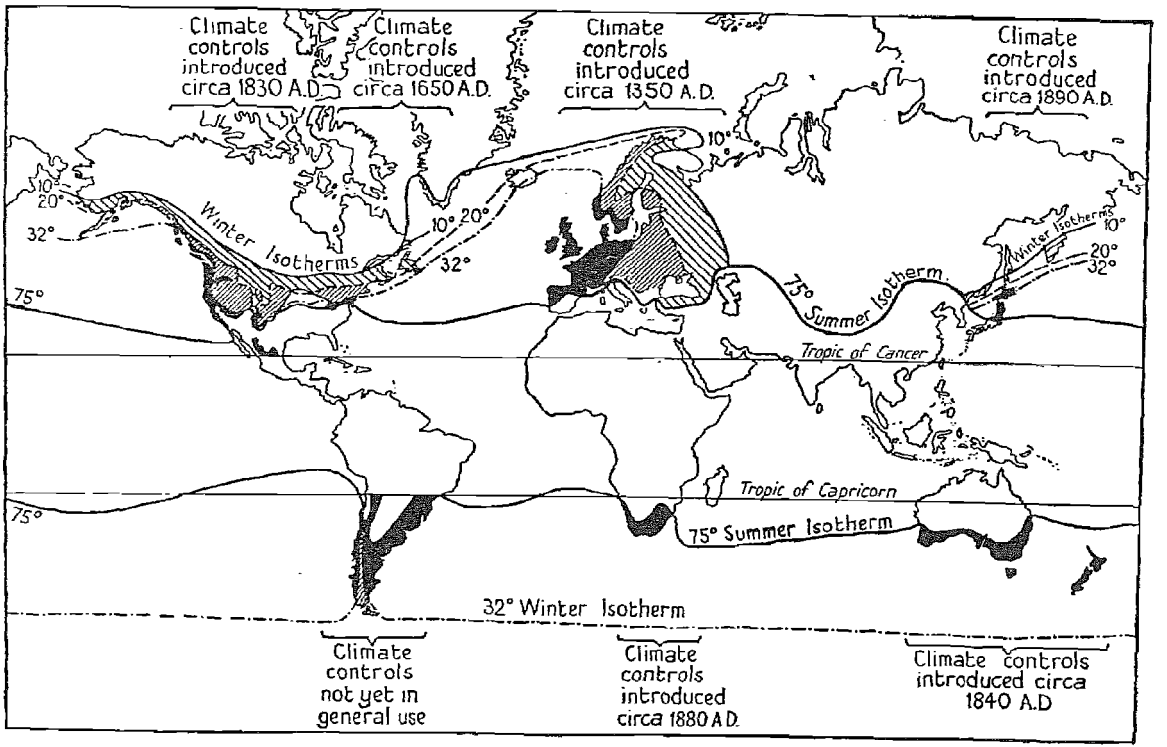
CLIMATES AND CLIMATIC CONTROL TO-DAY

A. THE NATURAL CLIMATE

It has already been pointed out that maritime and tropical areas are the ones where the extremes between summer and winter temperatures are least marked. An island such as Hawaii may, therefore, be expected to show the minimum deviation from the mean for its latitude. For Honolulu the temperature records go back 50 years and the difference between the mean temperature of the coldest January known (1905) and the warmest August (1900) is merely one of 12.6° F., from 67.2° to 79.8° F. But a monthly mean of 75° F. or over implies that nearly every day will produce several hours with a temperature well over 80° F. or even 85° F. Thus it may be said that wherever the temperature for any place for the hottest month passes the mean of 68° there will be many hours in that month when people will be subjected to climatic conditions too hot to be comfortable. At Greenwich, for example, where the mean temperature for the hottest month, August, is 62.6° F., several days occur nearly every year when the thermometer passes the 80° mark for perhaps an hour or two. There are, on the average, three days every year when the temperature rises above 85° F., and on eight occasions during the last 35 years temperatures of 90° or over have been registered both at Greenwich and at Kew for a short while.

Thus, London's 'heat handicap' amounts to at least three days per year, and on these days the temperature *for several hours* is over 76° and may rise higher than 85° for an hour or more.

If this then is the handicap of England, with her cool maritime climate, it follows that warmer countries, such as France, Italy, Greece, Mexico, etc., will have a much higher handicap, and up to about 1930 no method had been devised for the



AREAS OF THE WORLD WHERE TEMPERATURES FOR THE WARMEST MONTH DO NOT EXCEED A MEAN OF 75° F. AND FOR THE COLDEST MONTH DO NOT FALL BELOW A MEAN OF 32°, 20°, OR 10° F. TROPICAL AREAS WITHIN THESE LIMITS HAVE BEEN EXCLUDED BECAUSE OF THE GREATER INTENSITY OF SOLAR RADIATION.

cheap effective control of hot weather such as has been devised for cold weather.

The lowest temperature ever recorded in the British Isles was 23° F. below zero at Blackadder, Berwickshire, on 4 December 1879, and the highest temperature was 100.5° F. at Tonbridge, Kent, on 22 July 1868. But extremes of temperature which form the subject of newspaper headlines rarely persist for more than a few hours at most, and what we have to consider is not the exceptional weather of any town or country, but the average weather that has to be endured for at least a month at a time, since shorter periods, although affecting human efficiency, if outside the ideal range, will not have any pronounced deleterious effect if followed by better conditions. Thus the monthly mean of temperature is the best criterion for our purpose.

In assessing the climatic conditions under which nations are working I have adopted the following method. First, the centres of population are determined and their mean annual temperatures and monthly means established over the longest possible period. To give a concrete instance, in assessing the climate of Australia as a factor in human energy, it would be absurd to take one record from the extreme north, and others from the extreme east, south, and west and calculate their average, since the bulk of the population is concentrated on the south-eastern seaboard. I have, therefore, taken the six largest cities (with suburbs) as follows: [1]

Town	*Population* 1931	*Mean Annual Temp.* °F.	*Mean Temperature* °F. *Coldest Month*	*Warmest Month*	*Relative Humidity per cent* *Coldest Month*	*Warmest Month*
Sydney ...	1,240,000	63.2	52.7	71.7	76	68
Melbourne	1,020,000	58.5	48.6	67.5	82	60
Adelaide ..	324,400	63.0	51.7	74.1	77	43
Brisbane ..	317,000	68.9	58.5	77.2	75	68
Perth	210,000	64.2	55.2	74.1	73	66
Hobart ...	60,000	54.4	45.7	62.3	84	64

[1] Temperature and humidity figures in this and following tables are from *World Weather Records* of the Smithsonian Institution; Köppen, *Grundriss der Klimatkunde; Réseau Mondial;* and information supplied by the British Air Ministry (Meteorological Office). Where these sources differ, an average has been taken, giving equal value to each source.

Now since Sydney has twenty times the population of Hobart it is evident that the climate of Sydney and its immediate neighbourhood affects twenty times as many Australians as does the climate of Hobart and its immediate neighbourhood, so that we must weight the Sydney figures in proportion. Similarly, Melbourne must be given seventeen times the value of Hobart: Adelaide and Brisbane a little over five times, and Perth three and a half times. We thus arrive at the following idea of the 'average' climate under which the majority of Australians live:

	Mean Temperature of		*Relative Humidity per cent*	
Mean Annual Temperature °F.	*Coldest Month*	*Warmest Month*	*Coldest Month*	*Warmest Month*
61.8	52	71	78	62

For every country in the world I have worked out similar tables, with this modification, that the more populous the country the larger the number of centres that must be considered; thus for India, I have taken into consideration meteorological statistics covering the 24 largest cities, while for New Zealand, a much more compact area, the records for the 4 largest cities only have been considered. By this means we get, if not the most exact idea of the climatic conditions endured or enjoyed by the inhabitants of every country, at least an effective approximation; where there are two or more distinct climatic zones in a given country (as for example the United States, Russia, China, and South Africa) specific reference will be made to them.

With this method we arrive at the 'Table of National Climatic Conditions,' arranged in order of temperature from the coldest to the warmest countries, which is given as an Appendix.

For Canada the great annual temperature range of 71° F. at Winnipeg from the mean of the coldest month to the mean of the warmest month is offset by the comparatively narrow range of Vancouver, and the figure given approaches to within 2° of the mean annual temperature of both Montreal and Toronto.

Thus the maximum margin of error in any country is not

more than 2°, save in certain backward countries where meteorological information is very scanty.

The word 'tropical' has been appended to every country where the capital town or largest city is in the tropics. Shade temperature readings do not give a fair indication of the day warmth of these countries owing to the high radiation factor. To a lesser degree shade temperatures for countries such as Australia, South Africa, Greece, Mexico, and the southern United States, all within 40° of the Equator, do not accurately convey the impression of warmth felt in day-time under a blazing sun. Altitude emphasizes this radiation factor and F. F. Roget has pointed out[2] that at high altitudes in Switzerland the thermometer may range from well below zero at midnight to 120° when exposed to the rays of the midday sun.

Thus in attempting to estimate climatic conditions in various countries the way is full of pitfalls. It can only be repeated that the ideal climate is one where men neither shiver nor perspire when at rest.

It will be remembered that in Chapter III it was postulated that the ideal outdoor climate was one that ranged between 60° and 76° with a relative humidity of 40 to 70 per cent at noon, moderate air movement and adequate sunshine, and it was there suggested that these limits were rather wide. Yet there is not a single country in the world that enjoys these conditions for more than a few months at a time, although in certain small areas they prevail nearly all the year round. California for example (i.e. the area between San Francisco and Los Angeles) has almost an ideal climate throughout the year, and so has North Island, New Zealand, though in both areas humidity is a little higher than the absolute ideal, and there are a few days every year when the thermometer may rise above 85° and conversely a few days when it may drop to below freezing point.

From the tables given in the Appendix it would appear that the following countries have an almost ideal summer and an easily controlled spring, autumn, and winter:

Argentine (central area)	Austria (western area only)
Australia (southern portion)	Belgium and Luxemburg

[2] *Altitude and Health.* See p. 65 *supra.*

Canada (southern British Columbia, southern Ontario and part of Nova Scotia)
Chile (central area only)
Czechoslovakia (western area only)
Denmark
France
Germany
Ireland
Netherlands
New Zealand
Norway (southern and western areas)
Poland (western portion only)
South Africa (south-eastern area)
Sweden (southern portion)
Switzerland
United Kingdom
Uruguay (southern portion)
United States (western seaboard, New England, New York state, and an area near the Great Lakes)

In none of these does the mean temperature of the warmest month exceed 70° F. or that of the coldest month fall below 20° F., radiation is not excessive, and humidity declines in summer. To these might be added northern Portugal, northern Spain, north-western Italy, and parts of Greece, which, whilst having one or more hot months, have almost ideal conditions in spring, autumn, and winter. In Finland and the Baltic States the winter is somewhat severer, but the climate otherwise is good. Japan, which otherwise is favoured, has not only high summer temperatures but also high summer humidity; nevertheless it has, with the east coast of China and the Mediterranean coast strip, the best climate in Asia. The maps on pages 98 and 107 show these areas.

We should, therefore, expect to find civilization at its highest in the countries in this list provided other conditions are equal, for these are the countries where men and women may work and play practically all the year round. But no country has an ideal climate, and if use is not made of houses, clothes, heating appliances, and so forth, the variations from season to season, or from hour to hour, may sap energy and health. The principal factors in the control of climate up to 1938 were coal, which reigned practically unchallenged for several centuries, and electricity, which has been developing rapidly since about 1900. We must therefore next consider in what quantities these are available for domestic use.

B. COAL, GAS, AND ELECTRICITY

No form of climate control, whether based on coal, gas, electricity, wood, oil, or any other material, can be considered effective from the point of view of national energy unless it is cheap enough to be within the reach of the poorest. A given country may have an ideal climate for ten months of the year, but if its means of controlling two months of bad climate are restricted to the wealthy owing to the high local cost of fuel, or even of clothing, it will not be so well off as a country with a worse climate and cheaper supplies. Central Chile has one of the best climates in the world, but absence of fuels and of cheap textiles leaves it worse off than, say, Scotland, which has a far inferior climate.

It will, perhaps, be generally admitted that at present methods of cooling and de-humidifying a house to any extent are beyond the means of most workers in any country. Air conditioning, fans, and de-humidifiers are, it is true, becoming more and more common as a feature of the houses of the well-to-do in the United States and Canada, but even this is not sufficient to justify us in considering the control of high temperatures and their concomitant of high radiation as within the power of the masses of any country.

Of the warming and drying methods, the coal fire, with its supplement of gas and central heating, is still supreme, while the use of electrical and oil heating devices is gradually extending. Therefore, any country which has vast supplies of coal or oil, or can easily produce electricity, has means of providing its inhabitants with cheap methods of warming and drying their houses.[3]

Fortunately, we have accurate information about the amount of coal and the number of kilowatts of electricity produced per head per annum in many countries. *The League of Nations Statistical Handbook* gives us the following figures for the years 1930-32 and 1937-8:

[3] I have excluded wood from this discussion in view of the difficulty of ascertaining its consumption as fuel, and also because it is rarely used as a major fuel in regions of dense population. Oil also has been excluded from this chapter since it is seldom used for the general warming of rooms outside the United States. In that country in 1942, 8.7 per cent of all household heating plants were oil-fuelled.

Electricity

Production of Kilowatt hours per head per annum, 1930-32 and 1937-8

Norway	3070	3300	France	345	400
Canada	1589	2300	South Africa	313	590
Switzerland	1229	1500	Netherlands	241	320
U.S.A.	900	950	Italy	241	300
Sweden	814	1250	Japan	222	300
New Zealand	517	800	Czechoslovakia	191	250
Belgium	515	660	Denmark	164	200
Germany	409	700	Argentine	127	150
Finland	374	780	Spain	112	120
Australia	373	600	Poland	61	100
Austria	361	500	Irish Free State (Eire)	51	118
United Kingdom	358	600			

No other country produced more than 100 kw. per head per annum.

Coal and Lignite

Production in Metric Tons per head per annum, 1930-32 and 1937-8

United Kingdom	5.0	5.0	South Africa	1.4	1.9
U.S.A.	3.2	3.1	France	1.2	1.2
Belgium	3.0	3.6	Poland	1.1	1.1
Germany	2.9	3.7	New Zealand	1.0	1.4
Czechoslovakia	1.6	2.0	Hungary	1.0	1.0
Netherlands	1.5	1.6	Canada	.9	1.3
Australia	1.5	2.0			

No other country produces more than one metric ton per head per annum.

From these two lists it is clear that the following countries have sufficient supplies of coal or electricity to make heating methods accessible to all their inhabitants at reasonable prices: Australia, Belgium, Canada, Czechoslovakia, Finland, Germany, Netherlands, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, and the United States. The United States has also illimitable supplies of oil and natural gas.

In addition to these, the following countries have just about enough for their needs, but only enough: Austria, Denmark, France, and South Africa. Poland is next on the list, but

Poland's coal production of one ton per head per annum and low electrical output cannot be considered adequate to meet the rigour of the Polish winter and the industrial requirements of the country.

This list of countries, large areas of which have an ideal summer climate and an easily controlled spring, autumn, and winter, as well as adequate sources of artificial heat, coincides with the actual centres of civilization to-day.

Is it a coincidence that these countries are looked upon as being the most energetic? Perhaps the omissions are as startling as the list, for many would doubtless feel that Japan and Italy should be included in this last category, but we shall see from the following chapters that, judged by diverse tests, they do not reach the same high standard as the countries listed above.

My list of ideal countries (i.e. countries with an easily controlled climate all the year round) is based not only upon the consideration of statistics, but also upon personal experience of climatic conditions in almost every country of the world. Since this work was projected I have visited each of the five continents, and each succeeding journey has added new information, confirming the theory that man's energy depends basically on the climate in which he lives, that energy is a prime essential of any civilization, and that civilization follows climate control.

In short, the regions with an ideal climate (i.e. a climate that can easily be controlled all the year round so as to produce ideal indoor conditions and that permits outdoor exercise on most days), possessing at the same time cheap and effective means of climate control, are New Zealand, north-west Europe, and various portions of North America, South America, and Australia. New Zealand has a decided superiority over every other country in having an easily controlled climate and adequate sources of artificial heat available at moderate cost.

Let us subject now the nations of to-day to diverse tests, in order to determine whether energy does in fact coincide with good climatic conditions and good climatic controls.

VIII

TESTS OF NATIONAL ENERGY

THE DEATH-RATE AND INFANTILE MORTALITY

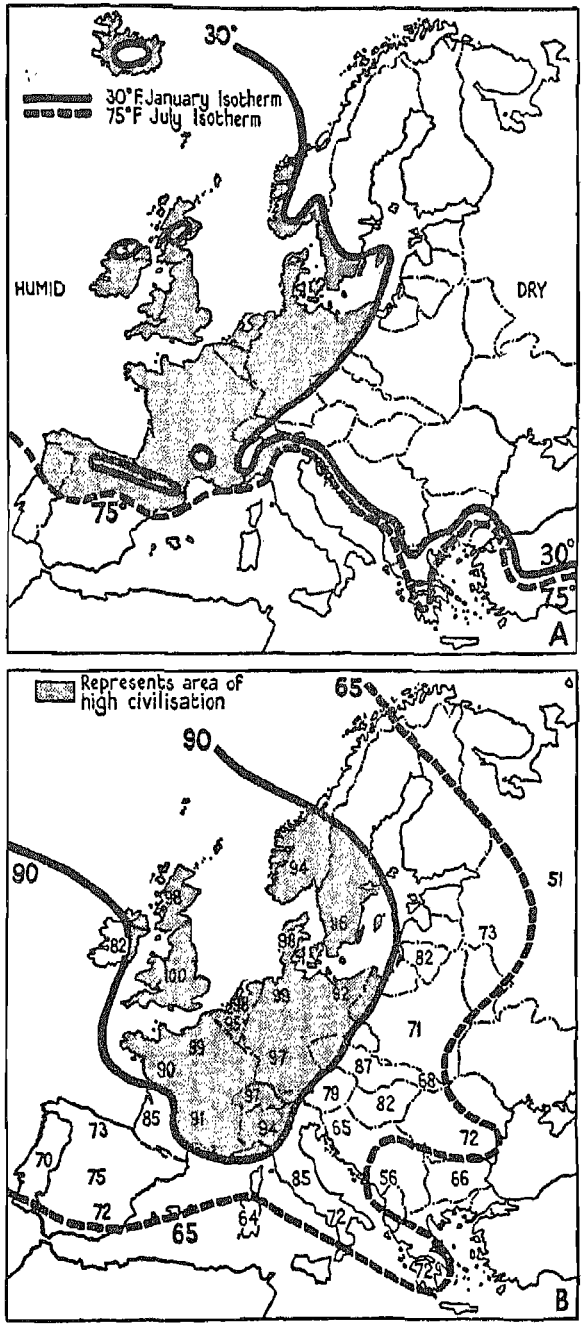
By what methods are we to test national energy? It is no doubt easy to say that Greece was great and energetic at the time of Pericles, and that Rome was great and energetic under Julius Cæsar, but are there any incontrovertible standards of assessing national energy?

Mere accession or retention of territory may be disregarded at once: no nation can be accounted greater or more energetic because it rules over more acres than its neighbour, for were this so Mexico would be ranked higher than Sweden, and Russia above all. Possibly a test that might be taken is that of the acquisition of territory by given countries over, say, several decades. It is a human characteristic to desire to extend one's area of power.

The two great colonizing powers of the world, Great Britain and France, have each a colonial history dating back hundreds of years. These two powers alone have dominions occupying 18,000,000 square miles, and containing 500,000,000 inhabitants. The full extent of overseas possessions of these and other powers was in 1936 as follows: [1]

	Home Area (sq. miles)	*Area of Dominions or Colonies (sq. miles)*	*Home Population 1936*	*Population of Dominions or Colonies*
Great Britain ..	95,030	13,900,000	46,600,000	454,000,000
France	213,000	4,600,000	41,900,000	65,700,000
Netherlands ...	13,214	812,260	8,300,000	62,800,000
Japan	260,800	116,500	66,500,000	28,500,000
United States ..	3,027,000	712,000	125,200,000	14,300,000
Belgium	11,750	960,000	8,250,000	13,500,000
Italy	120,000	1,200,000	48,000,000	12,500,000

[1] Figures from *League of Nations' Year Book*, 1935-6, pp. 18-23, and *Whitaker's Almanack*, 1939.



EUROPE: (A) CLIMATE; (B) CIVILIZATION (after Huntington).

In another direction the United States expanded from their original area of 819,466 square miles in 1776 to 2,974,159 square miles in 1890, and with the 'closing of the frontier' in the latter year came the beginnings of an overseas Empire, and 125,000 square miles were added in three years, 1898-1900.

These extensions of territory indicate a considerable virility on the part of the nations concerned, just as Spain's great losses in the nineteenth century marked a corresponding lack of vigour. But it is by no means a safe test of national energy, for Germany's great territorial losses in 1918 were due not to any lack of energy in the individual or mass, but to the fact that after a four years' war the massed forces of 600,000,000 people had beaten the forces of 100,000,000. It is true that had German diplomacy been better, some nations, such as Italy or Roumania, might have been enticed into the war on her side, the United States might have been kept neutral, and the result might have been favourable to Germany, with an eventual corresponding increase of territory for herself and her allies. But would this have proved, for example, that Austria-Hungary was more energetic than Belgium? Belgium certainly fought heroically, and the United States fought with equal determination in the last eighteen months of the war, but does the subsequent increase of Belgian territory by 35,000 square miles and of the United States territory by 132 square miles (through the purchase of the Danish West Indies for $25,000,000 in 1917) give us a measure of the comparative national energy of the two peoples during that particular period?

Similarly, is the acquisition of 48,506 square miles by the United States from France in 1804 for £3,000,000 to be compared with the reclamation of the Zuyder Zee by the Dutch during the period 1918-33—530,000 acres at a cost of £100,000,000? Again, the history of Denmark during the last 80 years shows how territory may be lost and re-acquired without credit or discredit to a nation's vigour.

It is evident, therefore, that whilst the acquisition of territory may give an indication of national energy, it cannot, and does not, afford anything like an accurate basis for comparison.

Similarly, the winning of wars, or naval or military strength, must be disregarded. A strong coalition may defeat the most energetic nation in the world. A country like Turkey, or

Greece, may in the short space of a dozen years win or lose two or three wars. Naval, military, or air strengths are equally fallacious. Is Switzerland to be placed in the lowest rank of nations because its armaments are relatively small? These are only the more obvious objections to assessing a nation's energy by its display of armed force.

Various other methods give rise to other objections, but a distinguished American, Mr. Frederick Osborn of the American Museum of Natural History, devised for the United States an 'index of cultural intellectual development' in the various states, based upon mental tests among school children, army intelligence tests, illiteracy percentages, magazine readers per 100 of the total population, and other criteria.[2] This index shows Washington, California, Massachusetts, Oregon, and Connecticut heading the list, while all the states of the south-east (except Florida), from New Mexico to Virginia, come at the foot of the list. A glance at the climatic records of the United States shows that the Pacific states have possibly the best climate of any, followed by Massachusetts and Connecticut, while Louisiana and Mississippi, which are at the foot of Mr. Osborn's list, are less favoured. Moreover the south-eastern states have a much higher humidity than the others.

Our inquiry would be rendered much easier if similar tests could be applied everywhere, but even the figures for illiteracy are difficult to obtain for the majority of countries. Unfortunately, we have no general intelligence test which we can apply to the nations of the world. Some such test has long been sought for, and interesting criteria, such as the production of 'great' men, illiteracy, inventive ability, and so forth, have been considered, but for none of these have we world-wide statistics that can be regarded as noncontroversial. Professor Ellsworth Huntington produced a fascinating study of civilization based on personal estimates that is illustrated on page 107; but it is very difficult to make correct allowances for personal preferences.

What then are the tests that we can apply? Human nature, it is said, is the same the world over, and certainly the desire

[2] Paper read before the Eugenics Society of America, May 1933, and referred to more fully in Chapter XIII.

to prolong one's own life, to be free from illness, to make money, and to be of good repute among one's fellows, is to be found everywhere, and human energy can in some sort be judged by the extent to which various nations attain these aims.

But how can their success be assessed statistically? The death-rates and infantile mortality rates help us with the first of the above aims; and success in money-making can be calculated from national incomes and world trade. I should have liked to take some other measure, such as inventions, but world figures here are misleading, since patent laws vary in various countries.[3]

Let us, therefore, first take the death-rates and infantile mortality rates; these reflect preventive medicine and human energy as much as the natural healthiness or unhealthiness of an area, for how otherwise are we to explain the striking decline in the death-rates in nearly all countries over the last twenty years? It is not that diseases have grown less terrible or potent, but that man's energy has extended his conquests over them.

It may be asked why infantile mortality, which is part of the death-rate, is shown separately and why importance is attached to its distinct rendering. The answer is that the death-rate by itself may give erroneous conclusions. For example, deaths from violence (probably 5 per cent of the total number in most civilized nations) and deaths indirectly due to war privations or injuries swell the figures. Emigration too may affect the figures. But greater than these influences is that of maturity. If a country has a very low birth-rate, it follows that the average age of the population will become progressively higher, and in countries such as France, Austria, Esthonia, and Sweden the height of the death-rate is due in part to an ageing population. Death-rates and infantile mortality rates for the principal countries are as follows:

[3] Up to 1934 the patents issued number approximately as follows: U.S.A. 2,000,000, France 900,000, Great Britain 800,000, Germany 600,000, Canada 326,000, Italy 280,000, Japan 84,000, U.S.S.R. 64,000, which gives the palm for invention *per capita* to the relatively small population of Canada. Patent laws, however, vary so much in different countries that the basis of comparison is not to be relied on. Ellsworth Huntington has studied this subject closely, and his conclusions, given in his 'The Geography of Human Productivity' in the *Annals of the Association of American Geographers*, March 1943, deserve detailed attention.

DEATH-RATES, 1926-35, PER 1,000 INHABITANTS AND INFANTILE MORTALITY RATES, 1926-35, PER 1,000 LIVE BIRTHS

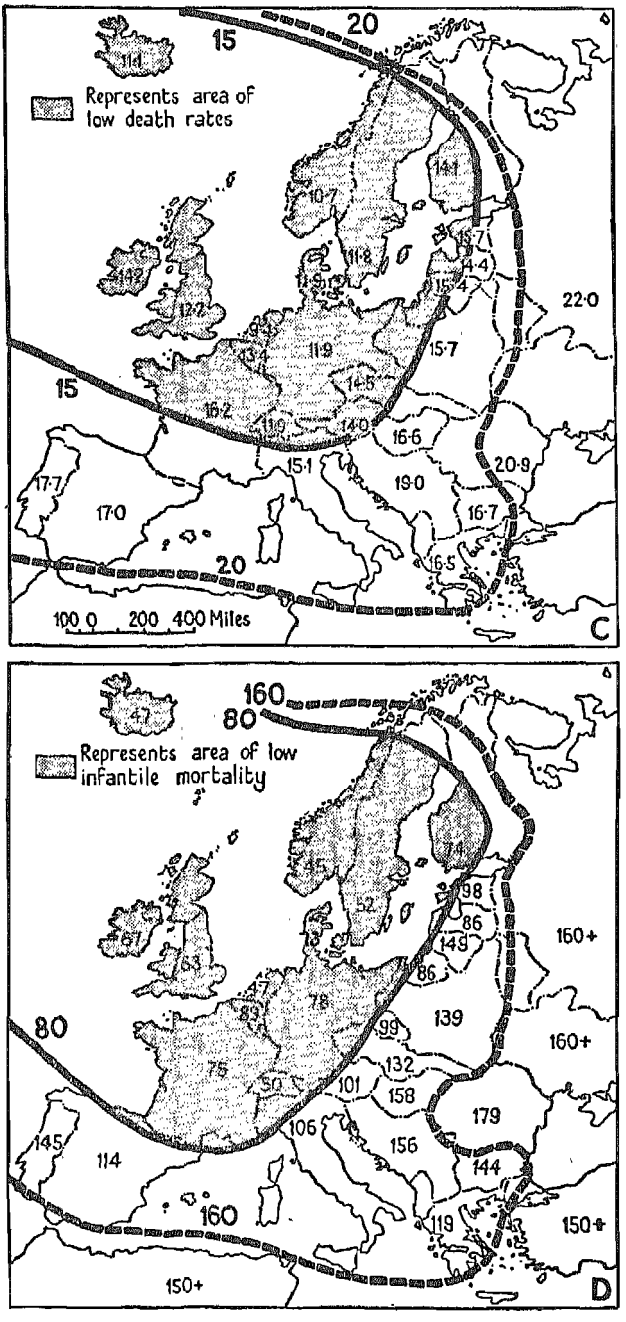
	Death-Rate	*Infantile Mortality*		*Death-Rate*	*Infantile Mortality*
New Zealand	8.4	40	Greece	16.5	121 †
Australia	9.1	46	Japan	18.6	128
Norway	10.6	47	Czechoslovakia	14.5	138
Netherlands	9.4	50	Salvador	23.3	140
Switzerland	11.9	52	Poland	15.7	142
Sweden	11.9	54	Portugal	17.7	146
United States	11.3	63	Bulgaria	16.6	147
United Kingdom	12.2	67	Venezuela	18.2	149 †
Irish Free State	14.1	69	Lithuania	15.4	150
Denmark	11.0	76	Yugoslavia	19.1	152
Finland	14.1	80	Philippines	18.9	154
France	16.2	81	Mexico	25.0	155
Canada	10.4	84	Egypt	27.0	158
Germany	11.4	84	Palestine	22.4	164
Belgium and Luxemburg	13.3	89	Hungary	16.4	164
Latvia	14.4	90	Ceylon	23.3	168
Uruguay	10.5	99	India (British)	23.7	174
South Africa	11.5	100 *	Roumania	20.9	187
Esthonia	15.7	100	Burma	18.0	201
Argentine	12.7	103	Chile	25.2	238
Austria	13.9	108	Russia	21.0	190 †
Italy	15.0	112	China	No figures	
Spain	17.0	118	Brazil	"	"

* *The figures for the white population are 9.8 and 65, those for the native population are about twice these, but in view of lack of reliable figures those given above must be regarded with caution. See Official Handbook of the Union, 1930-31, pp. 831 and 1020.*

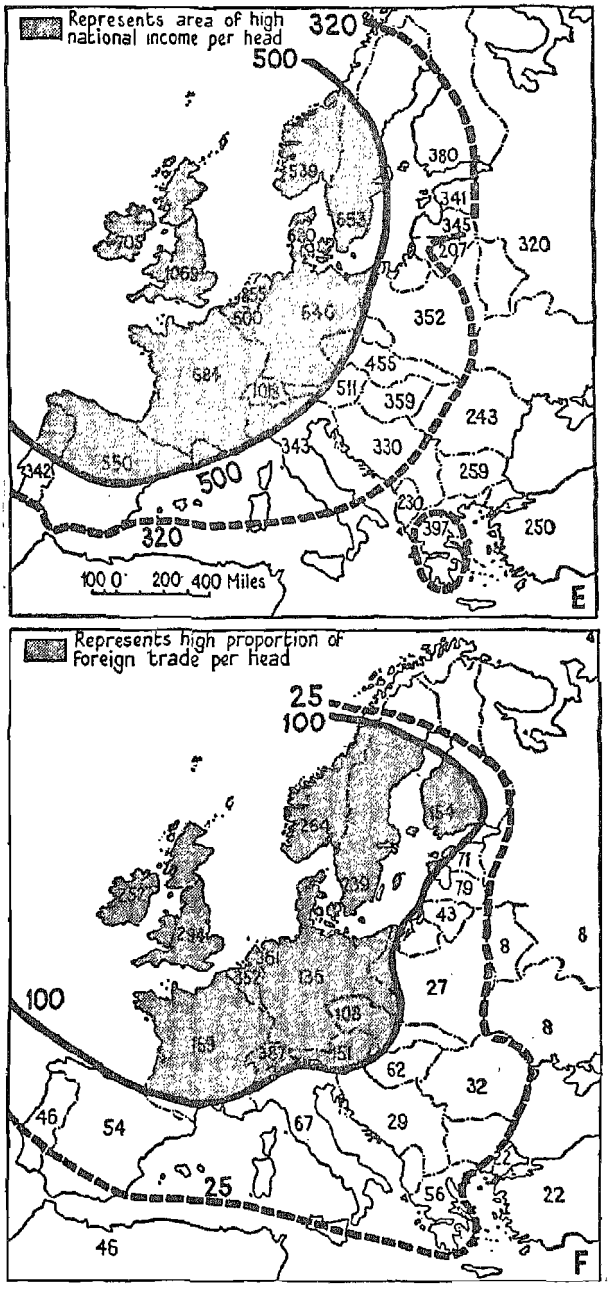
† Incomplete figures.

Possibly the infantile mortality rates give a better indication of national health and energy, since neither emigration nor deaths by violence greatly affect these figures, though in parts of Africa and Asia infanticide is still practised. There are, however, few who do not regard the saving of a child's life as a creditable action, and throughout the civilized world the care and successful upbringing of infants are looked upon as meritorious.

A glance at the figures given above brings out some striking facts. New Zealand, Australia, the Netherlands, and Norway occupy an enviable position on both counts, but as one runs



EUROPE: (C) DEATH RATES; (D) INFANTILE MORTALITY, 1930-34
(Cp. meteorological map on p. 107).



EUROPE: (E) NATIONAL INCOME IN INTERNATIONAL UNITS 1925-34; (F) WORLD TRADE, PROPORTION PER HEAD, 1926-35 (*Cp. meteorological map on p.* 107).

down the table curious discrepancies are observed. The Irish Free State (Eire) and France have relatively high death-rates compared with their infantile mortality rates, while Canada, Uruguay, and the Argentine seem to have relatively high infantile mortality rates. But in general the figures of either column do give us an idea of the healthiness of a given country; they also reflect in no uncertain manner man's effort to overcome disease and suffering. In every case, save perhaps one or two countries at the foot of the table, the figures show a striking improvement when compared with those of half a century ago, and in most countries the infantile mortality rates have declined by half. In the United Kingdom, for example, the infantile mortality rate has declined from 143 per 1,000 (1881-90) to 49 per 1,000 (1943). Similarly, in New Zealand over the same period the rate has declined from 87 per 1,000 to 32 per 1,000. The progress over two centuries is even more striking, for in 1750 Buffon estimated that one half of a given number of new-born infants would die before they reached nine years of age (*Supplément à l'Histoire Naturelle,* vii, 158).

I spent recently a few months in New Zealand and made many inquiries into its inspiring record of infant welfare services. The people themselves[4] attribute their low infant mortality to climate, race virility (both similar to our own and to those of north-west European countries), and *partly to legislative and educative measures, the latter adopted both by the State and by various organizations.*

It need hardly be said that it requires more energy and thought to improve the position of the leader in the great crusade against disease and accident than to follow in the paths that others have cleared.

I think it will be agreed that these tables therefore do give us an indication of energy, since energy is broadly dependent upon health. But before we advance to a consideration of other tests of energy it may be well to consider the climate and climatic controls of the best and worst countries.

All observers will agree that in New Zealand, Australia, the Netherlands, Norway, etc., the standard of life is such that all can afford well-built houses and the requisite fuels to ensure the warming of them. Further, I think it will be agreed that

[4] *New Zealand Official Year Book,* 1933, p. 109.

all of these countries and the other countries at the head of the list have climates which can thus be controlled for the greater part of the year. And as one goes down the table one is struck by the gradual worsening of the climates until the steamy heat of Burma or the arctic cold of Russia is met.

But there is one striking exception—Chile. It is true that Chile extends from the tropics to the frozen south, but the greater part of her population of 5,000,000 is concentrated in the centre, i.e. between Antofagasta, 23° S., and Concepción, 38° S. This area is climatically comparable with south-east Australia and North Island, New Zealand. All three countries are isolated from foreign-born epidemics, Australia and New Zealand entirely by sea, and Chile by the sea and the Andes. Chile has a population of 5,000,000, mainly of European origin, with indigenous Fuegians (nomadic in the extreme south), Araucanians (102,000 in the valleys or on the western slopes of the Andes), and the Changos of the northern coast region. The Australians and New Zealanders are also of European stock (mainly British), but there are a few Asiatics, and some 90,000 Maoris in New Zealand.

In Chile the total area of agricultural land (1927) was 59,038,055 acres; in New Zealand the total area of agricultural land (1931) in occupation was 42,239,585 acres.

If we compare the Chilean cities of Santiago and Valparaiso, which contain a quarter of the total population of the country, with the principal Australian and New Zealand cities, which contain about one third of their population, we find:

	Population in thousands	*Mean Annual Temp. °F.*	*Temperature °F.*		*Relative Humidity per cent*		*Lat. °S.*
			Coldest Month	*Warmest Month*	*Coldest Month*	*Warmest Month*	
Santiago ...	852	56.4	46.0	67.3	83	61	33
Valparaiso .	245	57.0	43.0	63.0	75	66	33
Auckland ..	218	59.0	52.0	67.0	82	73	37
Wellington .	140	55.3	48.0	62.5	78	72	41
Sydney	1240	63.2	52.7	71.7	76	68	34
Melbourne .	1020	58.5	48.6	67.5	82	60	38

But Chile produces only 0.4 metric tons of coal and lignite per head, New Zealand three or four times that amount, and

Australia five times; similarly, where Chile produces only 80 kw.h. of electricity per head, New Zealand produces 800 kw.h. and Australia 600.

Thus where south-east Australia and New Zealand have almost perfect climatic control indoors, Chile has very little, and the populated areas of all three countries require heating appliances for at least six months in the year to bring indoor conditions up to that point between 60° and 76° which is regarded as the local ideal.[5] The three regions are indeed comparable, yet Australia and New Zealand have the lowest mortality rates in the world, and Chile about the highest. Can it be, as the *Encyclopædia Britannica* suggests, that in Chile, 'although the climate is healthy and agreeable, the death-rate among the common people is abnormally high on account of personal habits and insanitary surroundings'? Is it possible that the known lack of energy in Chile may be due to lack of adequate methods of climate control?

Roumania likewise has neither coal nor electricity in abundance: she produces only 35 kw.h. per head per annum and very little coal. It is only in the past decades that her oil wells have been developed, but few of the peasants as yet use oil as a fuel.

A healthy rate does not, therefore, depend entirely upon natural climate, nor upon absence of industrial undertakings, nor upon the density or sparseness of the population. It does not depend upon proximity to the sea, for Switzerland shows some of the best figures, nor upon race, for the United States and Canada prove that the Negro can flourish in the temperate zones; likewise the Japanese appear to be more healthy in Hawaii than in their own country. But a good health rate does appear to depend upon man's control of his environment and disease, and as such is one of the surest tests of national energy.

[5] See above, Chapter III.

IX

TESTS OF NATIONAL ENERGY: NATIONAL INCOMES, AND WORLD TRADE

ONE of the surest indications of national energy is the effort to secure and retain wealth. The mere possession of money or property presents to the average individual a sure barrier, not only against poverty, but against discomfort in many other forms, such as ill-health in certain aspects, unhappiness due to a low social status, or the inability to follow congenial lines in work and recreation. The normal individual, therefore, will work and strive for money or a monetary equivalent, and whilst many will work for prestige or the sheer joy of achievement, the expectation of monetary recompense is no doubt one of the main incentives to human effort.

Yet the various nations show considerable differences in their capacity for money-making. The *per capita* wealth of various countries, pre-war, ranges from about £600 per head in the United States and the United Kingdom to a few shillings only in many equatorial countries; but the *per capita* wealth is a very poor test of national energy, since purchasing power, wage rates, etc., vary from area to area. National income is perhaps a better one.

A. NATIONAL INCOMES

For some time I hesitated about considering national wealth, national income, or private incomes as a test of national energy. It seemed to me that countries rich in natural resources and somewhat underpopulated, such as the United States, Canada, Australia, and the Argentine, would show much greater wealth *per capita* than other territories lacking great natural resources, such as Belgium, Holland, and Norway, even though the energy of the latter might be as great as that of the former. But a detailed study of Colin Clark's *The Conditions of Economic Progress* (1940) has modified my opinions to the extent that, whilst I am still unwilling to accept national income as an un-

challengeable estimate of national energy, I am willing to accept it as a broad comparative indication.

Clark has assessed economic welfare in terms of an 'international unit' which is defined as the amount of goods and services which could be purchased for $1 in the United States over the average of the decade 1925-34. As he himself says, 'The method . . . does not claim any metaphysical finality, and is indeed the measurement of only part of economic welfare, which in itself is only part of well-being as a whole.'

According to his summary,

> the world is a wretchedly poor place. An average real income of below £2 or $10 per week per breadwinner is the lot of 81 per cent of the world's population. A standard of living of over 1,000 I.U. per worker per year (or over £4 per week) is found only in U.S.A., Canada, Australia, New Zealand, Argentine, Great Britain, and Switzerland . . . About 53 per cent of the world's population, including the whole population of India and China, enjoy a real income per head of less than 200 I.U. (i.e. well under £1 per week).

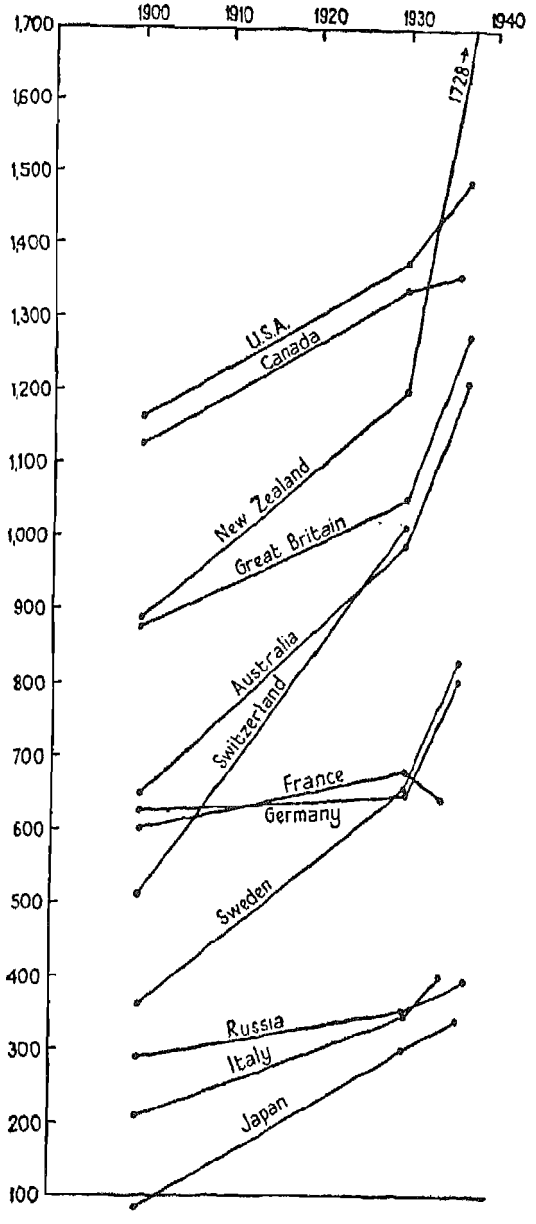
It is interesting to note that real incomes have been rising in most countries during the past half century; in New Zealand, Australia, and Switzerland the upward trend has been very rapid, while in Great Britain progress, though it has not been so spectacular, has continued.

The chart (p. 119) is a simplification of Clark's chart of real income per head since 1900. Clark gives the following figures of real income per head of occupied population in International Units for the decade 1925-34.[1]

U.S.A.	1381	Belgium	600	Portugal	342 *
Canada	1337	Spain	550 *	Esthonia	341
New Zealand	1202	Chile	550 *	Yugoslavia	330
Great Britain	1069	Norway	539	Egypt	325 *
Switzerland	1018	Austria	511	U.S.S.R.	320
Argentine	1000 *	Czechoslovakia	455	South Africa	276
Australia	980	Brazil	450 *	Bulgaria	259
Netherlands	855	Greece	397	Turkey	250 *
Eire	705	Finland	380	Roumania	243
France	684	Hungary	359	Albania	230 *
Denmark	680	Japan	353	Lithuania	207
Sweden	653	Poland	352	British India	200
Uruguay	650 *	Latvia	345	China	110
Germany	646	Italy	343		

* Approximate figures only.

[1] Clark, op. cit. pp. 40 et seq.



NATIONAL INCOMES PER HEAD SHOWING THE COMPARATIVE ADVANCE IN CERTAIN COUNTRIES, 1900-1940. (*See p.* 118)

It is interesting to note that the leaders in this table are, broadly speaking, those in the previous table given relative to vital statistics, but there are certain changes in order, as perhaps might have been expected. South Africa and Norway take much lower places, whilst the Argentine and Chile are surprisingly high, but Clark admits that these last two are only approximate figures.

B. WORLD TRADE AS A TEST

But before I begin to compare tables let us first consider another test of national energy, that of the share a given country can obtain of the world's trade. It is only to be expected that each area of the world will produce the bulk of its own material requirements within its own borders: where a nation does not do this—as, for example, during a great famine, or an exhausting war—a reduction of the general standard of living will ensue. But every nation in some field produces a surplus to its own requirements, whether of grain or of motor-cars, and if that surplus can be sold or bartered over the borders, the nation gains accordingly. At this point, however, it has to face the competition, the skilful, merciless competition, of the rest of the world: for whilst any country may restrict its own interior market to its own products, and make itself by various means the most favoured seller in its own area, the moment its goods cross the border they enter markets less favourable to them, markets where sales can be effected only by superior value, which in turn implies the production of commodities of a given quality at a lower selling price than that at which they are offered by its most favoured competitor. Hence, external trade is an indication of the measure of a nation's energy. The ingenious, industrious, inventive nation will devise ways of extending its markets even in the most unlikely fields. The indolent, corrupt, inefficient nation will gradually lose its external markets or, indeed, never acquire them.

How are we to test this phase of national energy? Exports and imports in terms of dollars or pounds are useless as an indication—for a survey of the export trade of the world during the years 1929-33 would lead one to suppose that the whole world had lost much of its energy, since the value of world

trade declined to a third during that period. Exports and imports in bulk are also fallacious, since a given bulk of cotton cannot be compared with the same bulk of a manufactured article such as clocks. But if we take the total volume of world trade and assess the percentage of it that a given country has secured over a period of years, we have a fair indication of the relative commercial energy of that nation, and neither tariffs nor any other form of commercial handicap will materially affect the conclusion. If a free trade country suddenly becomes stiffly protectionist, the total sum of world trade will be reduced by the limitation of imports into that country, and each of the countries formerly exporting to that market will have a more intense struggle for such other markets as still exist; the successful will show a rising percentage of the reduced volume of world trade, whilst the unsuccessful will drop down the scale.

It is, perhaps, beyond question that every country will endeavour to secure 'favourable' trade balances—i.e. to sell more than it buys—and countries will go to great lengths to secure this, and tariffs are a recognized weapon in the struggle. The Hawley-Smoot tariff in the United States in 1930, for instance, raised American duties on imports of manufactured goods to unprecedented heights; but it was also the signal for an outburst of tariff-making in other countries—none of which, of course, publicly mentioned the word 'reprisals.' Extensive increases in duties were made almost immediately by Canada, Cuba, Mexico, France, Italy, and Spain, and a year later general tariff increases were announced by India, Peru, the Argentine, Brazil, China, Italy, and Lithuania—not to mention Great Britain's adoption of tariffs in 1931. The Hawley-Smoot tariffs certainly restricted imports into the United States, but exports from the United States were in consequence much less welcomed than before.

Similarly, manipulation of the currency has been used to create a favourable balance. Controlled inflation, abandonment of the gold standard, and other devices have been adopted to secure the desired balance; but other countries follow suit, sometimes with a rapidity that bewilders their own producers as much as foreign importers. Before the outbreak of the War, the majority of countries of the world had abandoned the gold

standard, and had adjusted their currencies in some way or other. Each country will use the tariff or currency control as best suits it to further its own trade. The national percentages of world trade thus reflect the skill or lack of skill of the various nations.

It is evidently necessary that for this comparison any statistics considered should be free from national bias, and I have, therefore, taken the figures given in the 'Statistical Year Book' of the League of Nations. Unfortunately these tables apply only to the period since the War of 1914-18, but they have been supplemented to give some indication of the state of trade prior to that war.

Now in 1913 the leading commercial country of the world was the United Kingdom, with 13 per cent of the total trade of the world, the United States coming next with 11.17 per cent, closely followed by Germany and France. The rest were comparatively inactive. The war years not unnaturally reduced Germany's figure to a vanishing point, while the external trade of Great Britain and France also suffered considerably. By contrast, American and Canadian percentages rose from 11.17 (1913) to 15.5 (1926) and from 2.84 to 3.86 respectively.

To put it in another way, in 1913 Europe (including the U.S.S.R.) held 58.4 per cent of world trade, North America 14.1 per cent, and Asia 12.1 per cent. By 1926 the European figures had declined to 48.1 per cent, but North American and Asiatic trade had increased to 19.1 per cent and 16.6 per cent respectively; while South American and African trade remained stationary. Why should North America and Japan have captured European trade during these years, but not South America?

Again in the post-war years we note the swift dramatic decline of North American trade during the years 1926-34, not only in terms of dollars, but in terms of percentages of world trade. In the latter year North America took only 13 per cent of world trade, Europe 54.8 per cent, and Asia 14.8 per cent. We also note the increasing percentage of the United Kingdom, France, Belgium, and the Netherlands over the same period. The conclusion is inevitable, that while during the war, and the immediate post-war years, North America was clever and energetic enough to secure a great portion of world trade, it was not able to retain that percentage against the reviving

energy of Europe. Japan, however, retained her proportion and even increased it.

Let us consider what this trade struggle means in terms of one commercial product—the motor-car. During the period 1915-29 the United States, by virtue of superiority in engineering skill and sales methods, captured the world's market, and by 1929 was producing 5,358,000 vehicles, of which 583,000 were exported.[2] In the same year the United Kingdom produced 239,000, of which 42,321 were exported.[3] By 1932 the United States production had dropped to 1,371,000 vehicles, whilst British production had increased to 247,000. In other words, in a declining world motor-car market, Great Britain's proportion of the whole market had risen from 3.6 per cent to 12.4 per cent, and the United States' proportion had declined from 81 per cent to 69 per cent in the same four years.[4]

In the years 1932-5, however, Great Britain, whilst doubling its production and exports, took a smaller percentage of the total world market. America improved its sales, not only in Continental markets such as Holland, but also in Britain itself, owing partly to the devalued dollar, and partly to the improved appearance and performance of the American product. Meanwhile Germany, a negligible competitor in 1932, multiplied her production and exports sevenfold.

And so the struggle goes on—the struggle to produce the most popular article at a competitive price, the struggle to achieve the best conditions for that sale, whether by governmental action or mass suggestion. And the nation with the greatest number of ingenious specialists, of trained, alert business men, of equally alert and competent politicians, will extend its share of world markets in every direction where there is anything like a competitive field, and often where there is not.

We might turn from motor-cars to agricultural produce, such as wheat or beef. Here again, whilst each producing country can conserve its own markets for itself, *if it wishes*, the moment it begins to produce an exportable surplus it comes into the region of fierce competition. A country such as Great Britain, by far the largest importer of meat in the world, can

[2] *United States Commerce Reports*, 25 May 1931.
[3] *Hansard* 235, col. 247.
[4] *League of Nations Statistical Year Book*, 1935-6, p. 167.

pick and choose, and will indeed only purchase from those countries which, in turn, are likely either to sell most cheaply or to render equally valuable concessions in other directions. Up to 1933 Great Britain had made little attempt to reserve even a portion of its market for the home producer, but in that year an imports restriction policy, designed to assist the home farmer, limited all exporting countries, whether Empire or foreign, to a given quota. At the same time the German duty on frozen meat, together with stringent veterinary regulation, virtually prevented the importation of frozen meat into Germany, while the quota system in France and the Netherlands, and heavy import duties in Italy, Belgium, and the United States, all restricted the post-war market.[5] Previously, at Ottawa, Britain had assented to measures which favoured Empire imports.

The result was the fiercest 'meat war' yet seen between such countries as the Argentine, Uruguay, and Brazil, for what remained of the world market. The United Kingdom imported over 600,000 tons of beef (mainly chilled) every year, and up to 1933 over 70 per cent of this was received from the Argentine. Uruguay and Brazil were the only other suppliers of any importance of chilled beef, while Australia, the Argentine, and New Zealand were the chief sources of the supply of frozen meat.

In short, the Argentine was threatened with the loss of her greatest overseas market. Being energetic, she made every effort to retain it.

In February 1933 the Argentine sent a special mission to England to negotiate a commercial agreement, and on 1st May of that year a three-year Convention was signed under which the United Kingdom undertook not to restrict imports of Argentine chilled beef into the United Kingdom below the quantities permitted under the Ottawa Agreement Act, and then only after consultation with the Argentine Government, and that there should be no restriction of Argentine imports of frozen beef below the Ottawa levels, unless Dominion imports were similarly reduced. The Argentine in return made certain financial concessions, reduced certain duties on British

[5] *Cattle and Beef Survey*, 1934 (Stationery Office).

imports, and stabilized others. How much energy is required to conceive and negotiate an agreement of this kind?

These references to two specific trades prove very little, but when all the figures for all trades are added together *over a period of years* we must assume that the nation that gets a large portion of world trade has displayed considerable skill and energy. It will, of course, be granted that a currency change, a new tariff, or a new treaty may considerably improve the trade of a given country for a short period, but other nations can use the same weapon *and will do so* if national advantage can be secured thereby. It is the sustained volume that leads us to conclude that over a given period the quota of national energy is a high one.

Exports do not, however, tell the whole story, for countries such as Great Britain also sell shipping services and banking, insurance, and copyrights; Switzerland sells tourist facilities to foreign visitors, and many countries add something to their portion of world trade in this way. With the money thus gained from trade and services, imports from foreign countries are purchased, so that imports in a way give us a better idea of a nation's energy than exports; I have therefore taken both and combined them. The result gives us a combined figure for the selling energy of a nation and its purchasing power.

Thus of all the means that we can take to assess national energy, trade figures should certainly be considered; we must however remember that, other things being equal, a country with a population of 50 millions will do more trade than one with a population of a million, and therefore it is essential to take figures per 10 million population.

The League of Nations has given much thought to the problem of presenting accurate statistics in this field, and since 1929 has published annually in its *Statistical Year Book* comparable trade figures for all countries from 1926 onwards, including tables showing the percentage of world trade secured by each country. According to these figures the percentage of world trade secured by the five leading countries of the world from 1928 to 1935 was as follows: [6]

[6] In the following tables I have taken total trade figures excluding re-imports; the percentages for export or import trades do not vary much.

	1928	1929	1930	1931	1932	1933	1934	1935
U.S.A. ...	13.65	13.83	12.24	11.24	10.92	9.89	9.53	10.79
U.K.	13.13	13.05	13.38	13.47	13.38	13.59	13.85	13.93
Germany.	9.17	9.35	9.61	9.78	9.29	8.90	8.67	8.55
France ..	6.16	6.19	6.72	7.16	7.31	7.61	6.86	6.06
Japan ...	2.78	2.87	2.61	2.86	2.94	3.09	3.32	3.53

Now if we take the average of these annual figures for each country and divide the result by the tens of millions of population of each in 1931, we get the following proportions of the world trade per ten million population:

U.K.	2.94	Germany	1.36	Japan	.47
France	1.59	U.S.A.	.99		

The Economist and the *Statesman's Year Book* give us figures for earlier years that may be compared with these, for the *per capita* value of foreign trade has been:

	1908	1913	1929-33	1936
U.K.	£21.15.6	£25 18*s.*	£28 10*s.*	£26 4*s.*
France	£11.6.11	£15 7*s.*	£16 5*s.*	£11 7*s.*
Germany	£11.11.1	£15 4*s.*	£15 5*s.*	£10 8*s.*
U.S.A.	£ 7. 1.3	£ 9 0*s.*	£ 9 9*s.*	£ 7 6*s.*
Japan	£ 1.14.8	£ 2 12*s.*	£ 4 5*s.*	£ 3 8*s.*

The small difference between the 1908 proportion and the 1936 proportion is astonishing—for in spite of a world war, a boom, and a depression, all of unparalleled magnitude, the trade proportions per head are only fractionally different from 30 years earlier. Japan alone shows a definite increase, and Japan, as we have said before, is rapidly adopting the climate controls of the west.

It may be argued that a small country will automatically export and import more goods per head than a large country because of the limited range of its natural resources, but a glance at the full table given as an Appendix shows that if like is compared with like, whether in respect of area, race, or geographical position, the differences between such countries are enormous.[7]

[7] Areas such as British Malaya, Cuba, and Algeria appear to rank unduly high. But in each of these areas, as in some others, industry and commerce are largely controlled by men from optimum climatic zones; where this does not happen so much, as in Siam, Ecuador, or Abyssinia, the relative standard is lower. Some caution must thus be exercised in interpreting trade figures for colonies, and I have excluded colonies from the final comparison.

But the important fact is that the leaders in world trade in proportion to population are those countries which we have already seen have the lowest death-rate, the lowest infantile mortality rates, and the most efficient methods of climate control.

From the full table given in the Appendix it would appear that the countries with the greatest amount of world trade per ten million population are:

New Zealand . 4.80	Denmark 3.47	Norway 2.65
Switzerland .. 3.81	Australia 3.06	Eire 2.53
Netherlands .. 3.61	Canada 2.95	Sweden 2.39
Belgium 3.52	U.K. 2.94	

Is it merely a coincidence that these are countries where the mean temperature of the hottest month for the populated areas does not exceed 71° F. and the coldest month does not fall below 28° F. with the one exception of Canada, which, with the United States, has probably the most efficient heating systems anywhere?

Is it still a coincidence that the death-rates and infantile mortality rates are exceptionally low for these countries, or that in each of them climate control is effectively practised in practically every household?

The second group consists of:

Argentine 2.03	Finland 1.54	Uruguay 1.43
South Africa .. 1.90	Austria 1.51	Germany 1.37
France 1.59		

The position of the United States, still lower, is in remarkable contrast to her position in the national income list. It is of course possible that a country with such striking natural resources and industrial ability as the United States may want little in the way of imports, but her manufacturers have always shown remarkable eagerness to sell abroad. Possibly, as has already been indicated, the tariff policy of the United States unduly restricts these figures.

The rest of the list follows with impressive agreement, and at the foot of the list we have countries where the death-rate and infantile mortality rates are abnormally high, and where climate control is non-existent.

Possibly the most curious coincidence of all is that New Zealand heads every list[8]—and is the outstanding example of a country with a climate very near to the ideal coupled with an almost perfect climate control.

SUMMARY OF THE TESTS

If we take these four tests now, and consider the position of the various countries in them, we are at once struck by the fact that the following countries take a high place in each: New Zealand, Australia, the Netherlands, Switzerland, Canada, the United Kingdom, Denmark, Norway, the United States, and Sweden, while the following regularly occur with a fairly high position: Eire, Belgium, the Argentine, Germany, Uruguay, and France. This list of leaders is in striking agreement with the list of countries given on pages 101-102 and the areas illustrated on page 98 as having an almost ideal summer and an easily controlled spring, autumn, and winter, and with the list given on page 104 of countries which have sufficient supplies of coal or electricity to make heating methods accessible to their inhabitants at reasonable prices.

Next in order on the combined lists are Finland, South Africa, Austria, Latvia, and Czechoslovakia, each of which has a climatic or fuel handicap of some kind compared with those countries listed above. Italy, Spain, and Japan are the largest countries in the next group. Finally, at the bottom of all lists are the tropical countries, or continental countries such as Siberia and China, where the extremes from winter to summer are most marked and fuel supplies scarce.

The comparison between meteorological conditions and these tests as far as Europe is concerned is brought out in the maps shown on pages 107, 112, and 113. I think these tests and this series of maps do tend to prove that civilization and energy depend to no little degree on climate and man's control of it.

[8] It heads the list for national income for the years 1936-7, but the Netherlands has better health statistics for those two years.

X

THE BRETTON WOODS ASSESSMENT, 1945

THE foregoing chapters are an endeavour to assess the energy of nations by purely scientific methods. As the reader will have noticed, they are based on statistics checked and re-checked by the League of Nations Statistical Bureau, and they have for their central point the decade centred on 1931.

In 1945 the United Nations Conference at Bretton Woods, New Hampshire, was faced with a similar problem, which might be described as 'What voting powers or proportions ought the various nations of the Allies to have in the new International Organisations that were going to be set up?' Naturally the Articles of the Conference do not put it as bluntly as that, but in both sets of Articles (i.e. those that set up the International Money Fund, and those that set up the International Bank) it says, 'Each member shall have two hundred and fifty votes plus one additional vote for each part of its quota (or share of stock) equivalent to 100,000 U.S. dollars.' The quota or the share holding for each nation was determined by the Conference.

This is the first time in history that nations have been given a vote in this manner, and while there was undoubtedly some political give and take in deciding the quota or share allocation, the results show that in the main the Conference had been guided by the financial and trading strength of the various nations. It is interesting to note that when the proportions are analysed per capita, there is almost a direct agreement with the summary indicated at the end of the previous chapter. The full Bretton Woods quota and share allocations are given in the agreement; from this it will be seen that the United States and the British Empire control about 50 per cent of the voting. It will also be observed that enemy countries, such as Germany

and Japan, are not yet included, nor are the neutrals, such as the Argentine, Switzerland, or Sweden, nor co-belligerents such as Italy.

The main voting strengths are apportioned among the following countries:

Country	*Quota for the Monetary Fund (million dollars)*	*Shares in the International Bank (million dollars)*
United States	2,750	3,175
United Kingdom	1,300	1,300
U.S.S.R.	1,200	1,200
China	550	600
France	450	450
India	400	400
Canada	300	325
Netherlands	275	275
Belgium	225	225
Australia	200	200
Brazil	150	105
Poland	125	125
Czechoslovakia	125	125
Union of South Africa	100	100

No other country has a proportion of more than 90.

It will of course be understood that countries such as the United Kingdom, France, the Netherlands, and Belgium, are great colonial powers, whose colonies are entirely unrepresented otherwise than in the vote of their motherlands. As an indication of the financial-political status of the various countries the table is significant. The next question is whether, from our point of view, the sequence indicates the energy of the various countries concerned. If we break down the above amounts per country into amounts per head, we do in fact find, if not absolute agreement, at any rate a very interesting general agreement, with the health, wealth, and trade statistics per head given in the previous chapter.

Following is a list of the respective contributions to be made per head:

Country	Population 1940	Quota for the Monetary Fund (dollars per head)	Shares in the International Bank (dollars per head)
New Zealand	1,700,000	29	29
Netherlands	9,200,000	29	29
Canada	10,500,000	29	23
Australia	7,100,000	28	28
United Kingdom	48,000,000	27	27
Belgium	8,500,000	26	26
United States	136,000,000	21	23
Norway	3,000,000	17	17
Cuba	4,300,000	11.5	8
Chile	4,400,000	11	8
France	42,000,000	11	11
South Africa	9,600,000	10	10
Iceland	100,000	10	10
Czechoslovakia	15,500,000	8	8
Costa Rica	600,000	8	3.3
Uruguay	2,000,000	7.5	5
U.S.S.R.	200,000,000	6	6
Greece	6,700,000	6	3.8
Colombia	9,500,000	5.1	3.6
Mexico	19,500,000	4.6	3.2
Yugoslavia	15,000,000	4	2.7
Poland	35,100,000	3.8	3.8

No other country is assessed at more than $4 per head in the monetary Fund, or more than $3 per head for the Bank.

The position of the first dozen on this list are in general agreement with Clark's list on page 118 and with the list of leaders in World Trade given on page 128. There is also a striking series of coincidences with the mortality positions on page 111 and with the climatic list on page 101. Since none of these things controls climate, it is just possible that climate and its controls may be the ultimate unrecognised basis of the Bretton Woods assessments!

Russia and Cuba would, however, appear to rank high if judged by our former tests. But Russia during the last few years has acquired Finland, Latvia, Esthonia, Lithuania, part of Bessarabia, and part of Poland, Finland, Esthonia, and Latvia have always had relatively good health and wealth figures, and even Poland and Lithuania have always been in advance of Russia judged by per capita returns. These accessions, of over

20,000,000 souls, have therefore much improved the average of Russia.

Cuba is a conundrum. Why it should rank so high per capita I have no idea, unless that it be that the U.S.A. felt a special interest in this country, and wished to be certain that it was well represented. The same remarks apply to a lesser degree to Colombia and Costa Rica.

Finally, it is interesting to note that the United States may be expected always to carry with it such countries as Colombia, Panama, and Cuba, where American influence is extremely high. This brings the U.S. vote to 2,850 and 3,245. The British Empire (assuming Canada acts with the United Kingdom instead of with the U.S.A., which, however, is a very doubtful conclusion) is represented by only 2,350 and 2,375.

In short, the Bretton Woods Agreement recognises the fact that world leadership has passed to the United States. It recognises the eclipse of France, the rise of Canada, and the general backwardness of all tropical countries whether nations in their own right or colonies.

For good or ill, the sceptre of world leadership has been grasped by, or placed in the hands of, the United States. Whether she will hold it for a decade or for a thousand years depends upon the energy of the United States itself. But it is extremely significant that the United States itself recognises the fact that, individually, the citizens of New Zealand, the Netherlands, Australia, the United Kingdom, Canada, and Belgium should bear a heavier financial-political responsibility per head than the citizens of the United States.

XI

THE 'POOR WHITES'

If the theory embodied in the previous chapters is sound, it must stand the test of antagonistic as well as of confirmatory factors. For example, if it is true that civilization advances with man's control over climatic conditions, is it also true that civilization deteriorates when man's control over his environment declines? We have already drawn instances of this kind from the history of Rome, but, as was then pointed out, data recorded 1,500 years ago may not be considered essentially accurate.

The question therefore arises whether there is any people that has experienced every conceivable climate and adopted every method of climatic control during its history, and, if so, how was its civilization affected in the various phases of that history? There are two notable examples of such a people, the Semitic and the Nordic—that is to say, the Jews, and some hundreds of thousands of the races of north-west Europe. From the time of the fall of Jerusalem in A.D. 70 the Jews have spread over the face of the Old World; from the time of Columbus the European races have spread over the New World.

As regards the Jews, it will be remembered that their original home was directly along the 70° isotherm. From the time of Abraham onwards, throughout the imposing line of their prophets, kings, and judges, all their great leaders were born with a few miles of the 70° isotherm, which is shown on the map (p. 41). But in the course of the Dispersion, Jews in varying numbers went north, east, south, or west. Wherever they remained on or near the 70° isotherm they continued to flourish, but those that went south into Abyssinia, subsequently becoming Falashas, those that went so far afield as Cochin in India, and those who went to other tropical areas, all deteriorated, until to-day there is little left of those ancient colonies but a religious tradition and dwindling numbers. Their civi-

lization gradually declined to lower levels, and their learning often became a meaningless rote.

Up to the fifteenth century every Jew of importance was born on, or near, the 70° isotherm, from Moses to Maimonides. But as the world centres of civilization moved north-west, so did the sequence of eminent Jews also come from the north-west. From 1500 to 1800 almost every Jew of importance was born in north-west Europe, and since 1800 in North America or north-west Europe. Here is perhaps the most startling example of a single race subjected to varying conditions, and wherever those conditions differed greatly from the previous best, suffering a severe and almost tragic decline in civilization.

There are probably half a million Jews in Palestine and adjacent areas now, but the leadership of the movement comes not from this ancient region, but from the new lands possessing climate control, and it is the Hertz's, Rothschilds, and Weizmanns who now lead Jewry where formerly it was prophets, priests, and kings from the 70° isothermic area.

As the Jews in certain conditions have deteriorated, so also have other races. However different the Provençal or the Italian is from the Scandinavian or Irishman, it is an astounding fact that during the last 400 years, whilst the white races have conquered the greater part of the earth, they have conquered tropical areas only at the expense of their own power, if by chance they have settled there. There are, of course, great areas, such as India, China, and the Dutch East Indies, where no permanent white settlement has taken place, but in comparable areas, such as portions of South Africa, the southern states of the United States and the West Indies, there has arisen the problem known to the world as that of the 'Poor White.'

In all 'Nordic' areas, unemployment, destitution, and lack of moral fibre are not unknown, but in the tropical and semi-tropical regions of the earth, wherever the white man has tried to settle, there has arisen an additional source of trouble which may be summarized as follows. When white men settle in warm climates the first generation appears to maintain its energy practically unimpaired, but those that follow show a gradual deterioration, a social and economic retrogression, until, as was illustrated in the play, *Tobacco Road,* the white man becomes

not only lazy, but also 'something considerably lower than a decent native.'

The problem presented by these degenerated white men has arisen in the southern states of the United States, in South Africa, the British West Indies, various parts of South America, and other tropical or semi-tropical areas. It has not arisen to any extent in India, Burma, Malaya, or China, for here the European or American soldier, missionary, or trader has frequent periods of leave and returns home after his years of service. The extent of the problem may be gauged by the fact that in South Africa alone out of 2,000,000 whites no less than 300,000 are 'poor whites.' Here is the opinion of the Hon. G. M. Huggins, Prime Minister of Southern Rhodesia, on the subject: [1]

> Actually what is happening is this—and you can see it happening in the Union of South Africa. The less efficient class of white is pushed out of business by the native, and there are something like 300,000 poor whites in the Union of South Africa. I do not know how many of you have seen a 'poor white,' but he is something considerably lower than a decent native, although his skin is white. This is the result of the intimate contact of two civilizations, where there has been no attempt to direct and guide the energy and output of these various people. One of the things I have put up to the Colonial Office is that they should now, right away, make a survey of the whole of the British Empire Possessions, with the inclusion of the Union of South Africa, of course, and make up their minds which parts ought to be merely administered by white people, and in which parts white people are to be allowed to live, and propagate their species, and settle. Having done that, it will be perfectly easy then to allow the native to have an outlet for his greatest energies and his greatest ambitions and allow the white to survive.
>
> Of course, it is an unpleasant fact—but you have to face facts in this matter—that in those areas where white settlement has been allowed, the indigenous native will not be allowed to have equality, either social or political. You have to face up to that and make it plain, and so make the position possible, and in that way help us to tackle this 'poor white' problem which is already commencing in Southern Rhodesia, and which has existed for some time in the Union.

Of the areas concerned, South Africa has been subjected to the most minute investigation. In 1928 the Carnegie Corpora-

[1] Speech in Westminster Hall, 18 July 1934.

tion of New York, backed by its almost limitless funds, originated a detailed inquiry into the 'poor white' problem in South Africa, employing for the purpose some of the finest brains in South Africa and America. The Commission was impartial and fearless, and its Report, *The Poor White Problem in South Africa* (5 volumes, 1932), covers the whole field from psychology to economics. I will not, however, interpret the Report: I will merely quote from the Joint Findings, and readers may draw their own conclusions.

According to the Report (I, vi-vii), the 'Poor Whites,' who numbered about 300,000, consist of:

(*a*) Persons of nomadic type
(*b*) 'Bywoners,' farm labourers and shepherds, who often move about considerably
(*c*) The 'Bushveld' type, living largely under pioneer conditions
(*d*) The poor type of woodcutter
(*e*) Small groups of indigent persons living along rivers or well-watered valleys
(*f*) Former independent farmers. All these live under rural conditions
(*g*) 'Poor Whites' who have moved to the small country towns and developed into 'Village Paupers'
(*h*) Those who have gone to bigger cities and earn a living as unskilled workers
(*i*) Most of the people who try their luck on alluvial diggings
(*j*) Persons for whom employment has been found on settlements and relief works or as manual labourers on railways

For all these groups, except (*g*) and (*h*), the tent, wagon, or simple hut of reeds or rush mats was, and is, the usual dwelling place (I, 35-44), while the (*g*) and (*h*) groups become slum dwellers in the main (I, 220-22).

About one-third of the dwellings inspected were unsuitable for civilized life. They were small, dirty, tumbledown, ill-furnished and unadorned. Another one-third were reasonably clean and orderly, but quite too small for family life. The rest consisted of simple, but respectable dwellings, meeting the requirements of civilized life . . . With the few recent and praiseworthy exceptions, little is done in the cities to provide better housing; in rural areas practically nothing of this kind is done [I, xviii] . . . They occupy miserable untidy hovels [V, 4].

Swellengrebel, 150 years ago, noted the primitive and degenerate conditions of pioneer farmers in the Karroo, 'living

in primitively constructed mud or wattle and daub huts, without suitable windows, chimneys, or dividing walls.'

The economic and social decline discussed is particularly noticeable among the white population of older settlement [particularly Dutch farming stock, but] we find the same typical forms of retrogression among some of the English-speaking community, who have been settled in South Africa for many years . . . This [poor white] population had been severed from European progress and development for many generations, and lived chiefly under the simple conditions of a pioneer economy . . . The manner of life of the rural population and their simple economic condition caused a type of mentality to develop . . . marked by narrowness of outlook, by lack of enterprise, and by a dread of the strange world outside the farm . . . It must be admitted that a certain lack of industrious habits contributed to the process of impoverishment . . . Great distances were (and often are to-day) an obstacle to market production, so that there was little incentive to increased exertion. In addition, they had gradually learned to reduce their wants [I, vi-x] . . . The patriarchal tradition, which was formerly very strong among rural families, helped to keep the descendants in customary ways of farming. But it was also in many cases a cause of inexperience in business and of lack of initiative and self-reliance among the younger generation, as well as of over-populated farms [I, xi] . . .

The data collected . . . show a high mortality rate among children. Many of the dwellings are defective—often extremely so—in respect of construction, lighting, and ventilation . . . This investigation seems to indicate that poverty and unsatisfactory diet generally had a more detrimental effect on their nutrition than malaria or other diseases. In principle, the results obtained from scholastic and intelligence tests support this conclusion, as 'poor white' children suffering from malaria did not score less (or much less) in these tests than 'poor white' children in most of the other areas . . . Neither epidemic diseases, nor insufficient nor unsuitable diet, nor climate, play an important part among the great primary causes of impoverishment. But conditions of poverty and ignorance lead to lack of food and to wrong diet. This weakens the resistance to disease, reduces his working power, and so makes the problem more acute [I, xiv] . . . The great majority of poor whites are of normal intelligence [I, xvii].

Such were the Joint Findings of the Commission. The supplementary individual reports strengthen these main conclusions of my own:

(1) The stock was originally the best in the world—since the parent nations of Holland, Germany, France, and Britain were, and are, among the world leaders of civilization.

(2) Only that portion of this stock which has been in the country for several generations shows signs of deterioration.

(3) Only that portion of the stock which has voluntarily relinquished climate control, or been compelled to relinquish it, has become 'poor white.'

(4) Of these 'poor whites,' those in areas where buildings are at their worst and climate control is non-existent—as in the arid plateau to the north of the Union—are the most degenerate, while those who obtain urban employment, with its concomitant of greater climate control indoors, rehabilitate themselves.

The report does not say that absence of climate control is a cause of the mental and physical degeneration of 300,000 whites in South Africa (one in six of the whole white population)—in fact, it never mentions climate control—but it produces serried ranks of facts which show most clearly that the decline of the white is accompanied in *every instance* by a lack of heating arrangements, lack of protection against the sun, and lack of cooling arrangements such as solid buildings.

I must devote one or two paragraphs to a detailed account of the South African climate. Mr. W. A. Murray, who reports on 'Health Factors' in the publication we have mentioned, records that, 'The natural environment of the farmer and his family was on the whole healthy and favourable . . . The climate was more favourable, with no very great extremes of heat or cold' (IV, 6). The mean monthly temperatures for the warmer and colder months of the Capetown-Durban area are 58° F. and 71° F., and of the Johannesburg-Pretoria area 50° F. and 67° F.—*almost* an ideal climate—so near the ideal that people forget to take precautions in the hot or in the cold weather. But in the areas outside those mentioned, the range extends from 40° F. to 72° F. at Moyeni and from 51° F. to 77° F. at Kenhardt. It is in these areas, outside the great cities, that the poor-white problem originated and continues acutely. At Frazerburg, Brakfontein, Hanover, Lindley, and many other places, the average night minimum temperature of the coldest month is below 30° F., and over the Union as a whole mostly below 40° F. By contrast, the average day maximum temperature rises to 92.5° F. in the warmest month at Umsinga and over 80° F. at most places in the Union. As we have seen earlier,

80° F. in the shade is often 120° F. or more in the sun, and almost without exception these 'poor whites' are much exposed to external conditions, having neither cool rooms, fireplaces, chimneys, nor electric appliances. The cooking is usually done out of doors, but fuel is scarce.

However bad the poor-white problem is in South Africa and the southern states of the United States, many are of the opinion that it is still more acute in the West Indies. Professor Ellsworth Huntington, in his *Civilization and Climate* (page 33) says, 'The process of making "Poor Whites" has probably gone farther in the Bahamas than in almost any other Anglo-Saxon community . . . a large portion have unmistakably degenerated. Witness their intense and bigoted speech, their sunken cheek and eyes, their sallow complexion, and their inert way of working . . . There is no real colour line. The British Government gives the Negro every possible opportunity.' And again on page 46,

> . . . at the time of the American Revolution a considerable number of Loyalists were so faithful to England that they sacrificed their all to escape from the new flag with its stars and stripes. Leaving their homes in Georgia and the other southern states they sought the British territory of the Bahamas. Other colonists came from Great Britain. Now, after three to five generations the new environment has had more opportunity than in South Africa to produce its full effect. Almost nowhere else in the world have people of the English race lived as genuine colonists for several generations in so tropical a climate. What has been the result? It has been disastrous. Compare the Bahamas with Canada. The same sort of people went to both places. Their descendants in Canada are one of the strongest elements in causing that country to be well governed and law abiding . . . In the Bahamas descendants of the same type show to-day a larger proportion of poor whites than can be found in any other Anglo-Saxon Community . . . the white farmer is scarcely ahead of the average Negro . . . this seems to indicate a marked retrogression of the white race in regions which are climatically unsuitable.

The climate of the Bahamas may be described as only moderately healthful, but enervating. There is no hookworm and little malaria. It is significant, however, that the mean temperature of the hottest months (June to Sept.) is 82° and that there is high humidity the year round. Infantile mortality is over 200 per 1,000, one of the highest rates in the world.

Still more examples of the degeneration of the white races in tropical or semitropical climates are given by Grenfell Price in *The White Settler in the Tropics,* and although the causes of this recession are often stated to be alcohol, isolation, interbreeding, lack of education, etc., the basic fact remains that in most cases the climate during several months of the year is over 75° and often there is high humidity.

The newest example of all comes from Algeria, where the French have settled for less than a century. No observer who visited this area in 1943 could fail to be impressed with the difference in certain areas compared with others. Where the settlers chose comparatively cool elevated sites such as Miliana or Constantine, there is every appearance of health and vitality, but in the flat 'frying pan' areas such as Orleansville and Bouira the children look pale and listless, and infantile mortality is high. Considerable perturbation was caused a few years ago when the official statistics recorded that the infantile mortality rates for the French were higher than those of the Arabs, and statistics for the latter are no longer published. But the rates for the French population are unquestionably much higher than those of France.

In the early chapters of this book we have seen that industrially the energy of the white worker diminishes when temperatures pass the ideal range; in the 'poor white' problem we have this unpalatable truth emphasized when unfavourable climatic conditions persist over many years.

Many have ascribed this deterioration of the whites to 'the intimate contact of two civilizations,' the lower pulling down the higher, but this has not happened in Canada, in New Zealand, or in the northern portion of the United States, for in these areas the Redskin and the Maori appear to be working up to white level, the pace apparently depending on the extent to which the 'natives' adopt the white methods of climate control. Huntington, too, has pointed out that in the United States the northern Negro farmer is more efficient than the southern white farmer.

Thus, whereas the original 'poor white' came from an area where indoor temperatures could easily be controlled all the year round—and *were* controlled—he emigrated to an area where temperature could not be controlled during the two or

three hot months of the year, and were not controlled during the one or two cold months of the year. He perspired at rest in the summer; he shivered at rest in the winter.

I cannot resist quoting one recommendation from the Carnegie Report on South Africa that seems to summarize the cause and the cure at once—'It should be the aim of education to help people to control their immediate environment.' This is precisely my view.

XII

ENERGY IN THE BRITISH ISLES

So far we have been using a large canvas and a bold design; it remains to be seen whether the principles already formulated can be applied to a smaller canvas with the same degree of scientific truth.

For this purpose it is obvious that we must have an area extremely well documented, whether from the aspect of meteorological information or any of the economic and cultural tests that might be applied. From any point of view, therefore, the British Isles is a good area to take for the purpose of such tests. For this small, comparatively compact area accurate meteorological statistics have been available for many years, and in other fields it might well be said that the available statistics are equal in accuracy and historical comparison to those compiled for or by any other country.

As we have before mentioned, the greatest handicaps that Britain suffers from climatically are cold and high humidity. It must, of course, be remembered that a high humidity carries with it great cloudiness and consequent lack of sunshine, but it does not necessarily mean heavy rain. According to a rainfall map, the area with the lightest rainfall in the country is Essex and the area surrounding the Wash, but a humidity map shows that the driest area is that extending roughly for 80 miles in every direction from Luton, but excluding the seaboard.

Obviously, if there is anything in the theory previously propounded, prosperity and culture should centre towards the south of this area, i.e. the dry-warm portion.

For the purpose of testing whether energy and health do tend to be better in the 'dry-warm' area I have taken two of the tests used in our national comparisons, namely the death-rate and infantile mortality, and in place of the income and trade tests, for which figures are not available by counties, I have chosen unemployment statistics. As a sort of cultural test, I give, also

in map form, Ramsay Muir's divided map of England. It will be seen that his line cuts diagonally across England from Plymouth to Scarborough. From the south and east of this line, he says, in his *Historical Atlas* (page 27), sprang nine-tenths of the men born before 1800 whose names find a place in the *Dictionary of National Biography*. I have gone through the supplementary volumes of the *D.N.B.* and find that the south-east still leads, and this conclusion is strongly supported by Havelock Ellis's *Study of British Genius*. According to the latter, Norfolk, Herefordshire, Oxfordshire, Worcestershire, Hertfordshire, and Dorset have produced more great men per 100,000 of population than any other counties.

The first map (A) shows the average temperature and rainfall in the British Isles. It will be seen that the driest region is the south and central part of England, and the most humid the Welsh, Scottish, and Irish coastal areas and Devon and Cornwall. Now if on this map we inscribe the 49° annual isotherm, it will be seen that the warmest-driest area of the British Isles is a group of counties running from Devon to the Wash and down to the south coast.

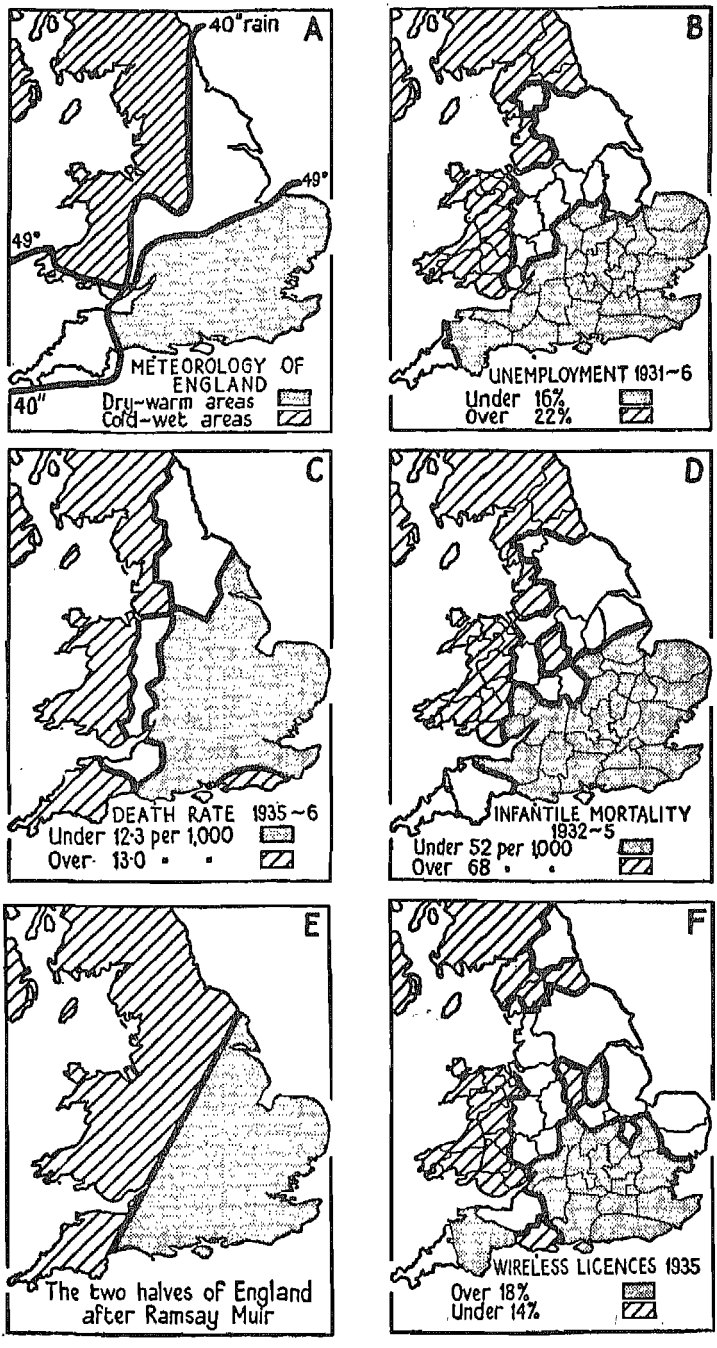
Comparable with these two maps are those (C and D) for infantile mortality and the death rates. These speak for themselves.

Above, at B, there is the map showing unemployment, 1931-6; this, too, requires no comment beyond the fact that at this period agricultural workers, domestic servants, and black-coated workers were not included in the insurance scheme, but nevertheless the figures give a fairly good indication of the prosperity or decline of a given area. The wireless map (F) is another indication of this kind.

Perhaps the first most striking agreement is that the counties with high unemployment are also the cold-wet areas, and that the counties with low unemployment are the warm-dry areas, and I suspect that if meteorology could be interpreted by counties, or unemployment by isotherms and other climatic elements, there would be an even more impressive agreement.

There is one further series of facts that might be considered in this connection, and that is in the trend of industry.

If we survey the last two centuries of the history of England we notice that before the Industrial Revolution the main



CLIMATE AND ENERGY IN ENGLAND.

centres of population were in the south, and even in 1801 it could be said that those centres were south of the Bristol-Humber line. But with the coming of the Industrial Revolution, and the ever-growing demand for iron and coal, industry centred near the iron and coal fields, not because these were the best areas, by any means, from the point of view of climate, but because in those days transport was of such an elementary kind that unless a manufacturer sited his industry near to the coal and iron mines he was likely to suffer from failure of regular supplies and from high charges for their conveyance. If we add to this another factor, the development of the textile industry, which demands a fairly humid atmosphere, we shall see that the trend of the population was necessarily towards south Lancashire and south Yorkshire, South Wales, and the Clyde.

But after the War of 1914-18 two factors of vast importance began to influence the siting of British industry, The first was the development of road transport, the second the transmission of electrical power. The motor-car and lorry and the development of electricity, with the establishment of a grid system throughout Britain, rendered it possible for the manufacturer to get his power as well as his supplies at any spot selected by him, and from 1922 onwards there began a great struggle between light or mobile industries established in the cold-wet areas and the same type of industries established in the dry-warm areas.

Industries are of two distinct kinds. The first may be termed geographical, and the second mobile. The geographical industries, such as mining or shipbuilding, must naturally be carried on where the mine or the sheltered waterway is. Neither quarry, nor mine, nor even breweries, can be displaced; but the manufacture of motor-cars, all forms indeed of engineering, of cloth-making, and a number of other industries or arts and crafts, can be easily moved about from place to place; these are the mobile industries.

The southerly trend of employment is strikingly illustrated in the annual reports of the Ministry of Labour. The Report for 1938 states that during the period 1923-38 the number of insured persons in employment in Great Britain showed an average increase of 21 per cent, distributed as follows:

	Per cent		*Per cent*
London	+44	North-Western	+ 3
South-Eastern	+60	Northern	+ 1
South-Western	+40	Scotland	+11
Midlands	+28	Wales	− 9
North-Eastern	+12		

Thus, in Great Britain as a whole, both employment and the insured population substantially increased during the period, and the increase was predominantly in the south. In the northerly divisions, however, and markedly in Wales, employment failed to keep pace with the increase in the insured population.

This remarkable change is evidently to be attributed to the fact that the light or mobile industries are finding their way to the south. In this respect it is interesting to note in the 1931 Census of Production that the following light industries were already well established in the south-east and London, and showed signs of developing with extreme rapidity:

PERCENTAGE OF TOTAL PRODUCTION OBTAINED IN THE SOUTH-EAST AND LONDON DIVISIONS, IN RESPECT OF THE FOLLOWING TRADES

	Per cent		*Per cent*
Scientific Instruments	65	Paper	53
Radio	59	Animal Foods	48
Typewriters and Calculators	58	Electrical Apparatus	46
Aircraft	57	White Lead and Paints	46
Biscuits	55	Sugar and Sugar Confectionery	43

It is possible that in a few years' time, when this transitional period will have passed, we shall find the industrial centre of England coming ever nearer to the Luton-Salisbury area, and that in the block of counties surrounding this point unemployment will vary in ratio (as it now does) in terms of dry-warmth to cold-wet.

It may be noted in passing that even the smaller areas, such as London, show a direct relationship between these unemployment figures and climatic conditions. The flat humid smoke-polluted districts of the East End have long been noted for their poverty, and the higher and cleaner districts of the north-west for their prosperity.

As a note of caution it should be added that comparable

charts for a few years may differ from those that are given here, since natural forces can be confused temporarily by human action. From 1935 to 1939 and from 1945 to 1947 the British Government was determined to modify the incidence of unemployment in the worst areas, and to this end offered great inducements to manufacturers to set up new industries in Cumberland, Durham, South Wales, and similar localities. The setting up of a single factory in a given area may have a great temporary influence on the unemployment figures; for example, the opening of an armament factory in the north-west helped to reduce the number of unemployed in that area by nearly 3,000. Sooner or later the physical forces of nature will triumph and a wiser and better advised government would centre these new industries in areas where they have more chance of competing successfully in world markets instead of in areas where they run greater risks of failure.

In short, it can be said that in an area so small as England there is very definite indication that mortality and unemployment are both low in the best climatic areas, and further, that industrial efficiency does seem to be affected by the outdoor climate as well as by man's control of it.

At the same time it should be remembered that no generalized maps, such as those given on page 144, will be accurate in every detail. Parts of Westmorland or Yorkshire have better climatic, health, and industrial conditions than parts of Hampshire; and Buxton, Harrogate, and Llandrindod Wells are far more bracing than Cheltenham, Bath, or Bournemouth. But all are preferable to the humid, smoke-polluted overcrowded slum areas usually in the east end of the great cities, where man has fouled his own inheritance.

Another factor that must be borne in mind is that however good or bad the outdoor climate, a great deal depends upon the intelligent use of climatic controls. It is a remarkable fact that Scotland and the northern counties of England, whilst having a colder climate than the Midlands, spend 20% less on coal, gas, and electricity than their southern neighbours. Sir William Beveridge in his famous report (page 86) gives the following figures of weekly expenditure on fuel in 'industrial' households for the years 1937-8:

	Family of 3	*Family of 4*	
North of England	4·30	4·55	shillings per week
Scotland	4·98	5·14	" " "
Wales	5·35	5·04	" " "
London	5·63	6·24	" " "
Midlands	5·75	5·91	" " "

It may perhaps not be too far-fetched to submit that the high infantile mortality of the north-west is due in some measure to a lack of adequate attention to climate control, particularly during the first hours of a child's life. Many Scottish, Welsh, and North of England houses have neither fireplaces nor electric heating in bedrooms, and under such circumstances a child may be born in a temperature well below 50°. To an adult the shock of a 40° drop in temperature when naked is sufficiently severe, but to a new-born infant it may well prove fatal. Among the most illuminating illustrations of the importance of good indoor conditions is that of a comparison of infantile mortality rates in Holland, England and Wales, and Scotland over the last half century. From 1881 to 1885 Scotland had a death rate of 118 per 1,000 babies, England and Wales 139, and Holland the high rate of 181. Just over fifty years later the order of merit was reversed, the rate for Scotland being, for 1936-40, 76 deaths per 1,000 births, the rate for England and Wales was 55, and that for Holland only 37—an astonishing achievement. During the last half century Holland has adopted central heating, electricity, and modern housing methods with an enthusiasm matched only by the northern states of the United States and by Scandinavia. England, too, has made great advances in many areas, but northern England and rural Wales have remained practically unchanged. Scotland, however, shows the least advance of any area. Gas and electricity are almost unknown outside the larger burghs, and Glasgow is still the most overcrowded and smokiest of all British cities. Small wonder that her infantile mortality rate has been over 97 per 1,000 births over the last ten years.

The facts bring out even more clearly that progress depends upon health and energy, and that among the basic essentials for good health and high energy in an area such as the British Isles are modern methods of providing warmth and ventilation in well-built houses in a good unpolluted natural climate.

XIII

THE UNITED STATES: CLIMATE AND HISTORY

It appears difficult to measure the progress and development of the United States of America by the same standards we apply to Europe or to any other part of the world where the population is indigenous or has been localized for many generations; for not only is there much migration from state to state, but there has been during the past century the greatest influx of 'aliens' that any country in the world has ever seen. The United States has been a melting pot of all European races, with Negroes, Japanese, Chinese, Hawaiians, Mexicans, and, of course, Red Indians added to the mixture. It is therefore pertinent to consider the United States first from the point of view of its historical development, and then to consider its climate, its climatic controls, and finally its present civilization and energy.

One of the most profound observers of our day, Dr. F. P. Keppel, former president of the Carnegie Corporation of New York, once asserted that while progress in each separate science is slow, painful, and often disappointing, research at the point where two sciences meet, by a man trained in both, often results in startling new discoveries. If, however, the happy combination could not be found in a single individual, the same object might be attained where kindred spirits, each with a different fund of knowledge and experience, were brought together to investigate problems common to both. On this analogy, where skilled workers, Scandinavian and Dutch, British and German, are intermixed, whether they be carpenters, plumbers, builders, or farmers, and are set working side by side, each will learn from the other's fund of knowledge and experience, and the resulting compromise of ideas may amount, in effect, to a new development.

The development of the United States during the past three centuries has in short been a process of this kind. The nations

of Europe sent men and women by the million: they came from Britain and France, from Germany and Russia, from Scandinavia and Italy. On the West Coast the mixture was increased by an element from the Far East; in the South the Negro brought what little Africa had to add to the ferment; whilst the Red Indians, the original inhabitants, apart from their courage, their stoicism, their knowledge of canoe building, and their husbandry, had little to teach the Europeans. They had not learnt how to use metal, how to write, or even how to build a home. Only the Iroquois were notable and numerous amongst a population so small and so backward that the level of the Aztec civilization in Mexico was centuries ahead of them.[1] The Iroquois, whose stronghold was western New York, have been described by the historian Parkman as an island of high intelligence surrounded by a sea of Algonquin mediocrity. It is perhaps significant that this Iroquoian confederacy had a comparatively high type of habitation. While the western Indian lived in skin teepees and the Algonquins had low oval wigwams of sticks and bark, the Iroquois dwelt in their famous 'long houses' of which such excellent models and reproductions can be seen in many museums from Buffalo to New York. These windowless bungalows, 15 feet wide and 30 to 100 yards long, were built of saplings and bark, forcibly suggesting a prehistoric Pullman. A central aisle gave access to a series of compartments partitioned by bark and open to the centre. Each compartment was occupied by one family, including children and dogs, and each family had its own fire, with a hole in the roof overhead to permit the escape of smoke. Wood was the only fuel. These 'long houses' and the wood fire were, in addition to clothing of skins and leather, their only defence against cold. They had not reached the stage in building that the Israelites had attained three thousand years earlier. Yet they were undoubtedly the most advanced of all Indian tribes north of Mexico, and the early Dutch, English, French, and Swedish settlers copied the massive timber palisades which protected their villages and their river transport system.

In the first century of European occupation (1550-1650), the

[1] The Indian population east of the Mississippi was not more than 200,000. See Allan Nevins and Henry Steele Commager, *America, The Story of a Free People*, p. 4.

invaders mixed but little. The English developed New England, Virginia, and Maryland, whilst the French developed Nova Scotia and the St. Lawrence area. The Dutch turned north up the Hudson, and the Swedes (who then included the Norwegians and the Danes and were a mighty power in Europe) swung north up the Delaware. Still further to the south the Spanish ruled or claimed an area extending from Florida to Texas and including all Mexico. Contact between these various colonies was rare; and all the time there were sporadic unpredictable wars with the Indians.

To this raw, new, underpopulated continent the first British settlers came in bold groups. The first in 1607 laid out Jamestown, Virginia, with a fort, a church, a storehouse, and a row of little huts. By luck or judgment they had come to an area where the climate was propitious, for the temperature of the coldest month was rarely below an average of 40° F. (London's average is 39°) and the warmest month of summer seldom showed an average of over 78° F. By 1619 its population numbered 2,000, and in that year a Dutch ship sold 20 Negro slaves to the settlers. In 1620 the *Mayflower* cast anchor on the Massachusetts coast, where much sterner climatic conditions met the Pilgrim Fathers: in that winter more than half of them died of cold and scurvy. In 1623 the Dutch effected a small settlement on Manhattan, and in 1634 an English group began the settlement of Maryland. About the same period Swedish, Dutch, and British settlers found their way into Pennsylvania and Delaware, whilst the older colonies developed rapidly.

It is interesting to consider what type of housing and heating these early settlers had. From each of their motherlands they brought the use of the grate, the chimney, and oiled paper in the place of glass. The style of architecture was broadly that of their native lands, circumscribed by the lack of certain materials. But their earliest houses, mostly log shacks, were doomed to a comparatively short existence as a result of fire, insects, fungus or rot, and none of these early structures remains to-day. The oldest existing houses belong to the next decade or two, the most striking being in Massachusetts, where the Fairbanks House at Dedham and the Whipple House at Ipswich show the type of construction that prevailed about 1630. The former looks for all the world like an old English

farm house, such as can still be found in East Anglia. The oldest stone building in the North is probably the Whitfield house at Guilford, Connecticut, built in 1639, and the oldest brick building, the Tufts house at Medford, constructed about 1668. Many similar examples of this period can be found in Virginia and Maryland. From then onwards many examples are available, and are all admirably described and illustrated in L. V. Coleman's *Historic House Museums*.

These stone or brick houses were generally small (one or two rooms only), with ponderous chimneys, steep gabled roofs, and high windows, the whole solid and workmanlike. In the South houses were compact, with peaked dormers, and chimneys were outside at each end—all in the spirit of Tudor England or the attractive Dutch style.

Meanwhile the Swedes had introduced the horizontal log cabin in their settlements along the Delaware, and it became the model for construction wherever the pioneers of the next three centuries blazed new trails through forest or over mountains.

The French, settling in what is now eastern Canada and along the Mississippi, with scattered posts like Detroit, old Mackinac, and Vincennes, colonized less. Port Royal was first settled in 1605 and Quebec in 1608. Only a few of their houses survive, crude by comparison with the Dutch or English trimness. New Orleans grew from a settlement of rude cabins of vertical cypress boards roofed with cypress bark—not unlike the Iroquoian long houses, but without the length and with windows.

In Florida the Spaniards, who had been there since 1565, built flat-roofed houses of masonry, but with no fireplaces. In the far Southwest, the Spanish missions were built of adobe (unburned sun-dried bricks)—thick-walled and flat-roofed structures rather like North African Moorish architecture, again without fireplaces, and with unglazed windows.

In all the various types of dwellings, wood was practically the only fuel, whether for cooking or heating. It is true that Hennepin and La Salle discovered coal in Illinois in 1679, but its general use as a domestic fuel was delayed for many years, owing to difficulties of transport and to the apparently endless abundance of wood.

Whatever the style of architecture, one thing soon became obvious, that it had to be modified to meet the demands of farming communities. The early Englishmen who came to America came to seek the Northwest Passage, to oppose Spanish or French expansion, to seek wealth in furs or fish or precious metals such as those of Mexico and Peru, or at least to secure profitable cargoes. The fact that the colonists needed to sustain themselves by farming was understood very slowly. In the course of a few decades New England grew maize, beans, and pumpkins alongside grains from Europe. In the South tobacco and cotton soon came to be dominant. Virginians discovered that their climate was well adapted to the growing of tobacco—and they made the discovery just as the English were acquiring the tobacco habit. Eventually, tobacco cultivation spread across the upper South. The second great discovery was that the southern climate was adapted to cotton, and the cotton plantation system gradually spread to the Southwest.[2]

But 'the basic pattern of the American farm,' says Sauer, 'is derived chiefly from the Middle Colonies,' which saw the greatest influx of true tillers of the soil. Here were neither southern plantations nor close-knit New England townships, but scattered single-family homesteads based on Old World farming models, with the addition of maize. German immigrants now arriving were mostly general farmers, accustomed to animal husbandry. They practised manuring and crop rotation, and introduced improvements in grain-growing, stock-breeding, and stabling. Other items of importance credited to the colonists from the Rhine are the introduction of the rifle, the Conestoga wagon, and the stove to replace the English fireplace.[3] The last was in many ways the most important, though its use did not become general, owing to 'stove malaria,' until various technical improvements had been effected.[4]

At the end of the seventeenth century the classical influence in architecture reached America, and during the next two or

[2] Hambridge, in *Climate and Man*, p. 15. This volume is a symposium by various authors, published under the authority of the United States Department of Agriculture.

[3] Sauer, in *Climate and Man*, p. 165.

[4] 'Stove malaria' was the name given to a curious heavy sickness caused from sitting around a stove and absorbing combustion gases which percolated from the stove into the room.

three decades interiors and exteriors in the towns and villages were modified. Fireplace openings were reduced, ceilings plastered, walls panelled, and the 'Colonial' type of architecture came to stay.

During the years before the War of Independence the prosperity of Charleston, Philadelphia, New York, Boston, and other cities along the Atlantic seaboard developed into comfort and elegance. Virginia had a population of over half a million, while Maryland, Massachusetts, New York, North Carolina, and Pennsylvania were each approaching the 300,000 mark, and Connecticut and South Carolina the 200,000. All were confined to the coastal strip between the Atlantic Ocean and the Appalachian Mountains.

In this area only a small district had a climate comparable to that of north-west Europe. The 30° January isotherm runs just south of New York westwards through Pennsylvania, and the 77° July isotherm runs just north of the southern boundary of Virginia. One of the earliest observers, Captain John Smith, writing about 1610, likened the summers of Virginia to those of Spain but its winters to those of England, and noted the added storminess of the area by the curious phrase: 'The like thunder and lightening to purefie the air, I have seldome either seene or heard in Europe.'

A century later Peter Kalm, visiting Pennsylvania from Sweden, wrote in September 1748:

> It is true that in Pennsylvania, and even more so in the lands farther to the north, the winters are often as severe as in Sweden, and therefore much colder than in England and the southern countries of Europe. I found, for instance, that in Pennsylvania, which lies by 20 degrees farther south than some provinces of my fatherland, the thermometer of Celsius fell 24 degrees below freezing. And yet I was assured that the winters which I spent there were not of the coldest, but quite ordinary. It is also true, however, that if the winters are at times hard, they do not usually last a great while. One can say properly that in Pennsylvania ordinarily they do not endure more than 2 months, sometimes not that long. Further, the summer heat is very strong and constant. Most of April, all of May, and the following months until October are as warm as June and July in Sweden. Cherries are often ripe in Philadelphia on the 25th of May; and not infrequently, wheat is harvested in Pennsylvania by the middle of June. All of September and half,

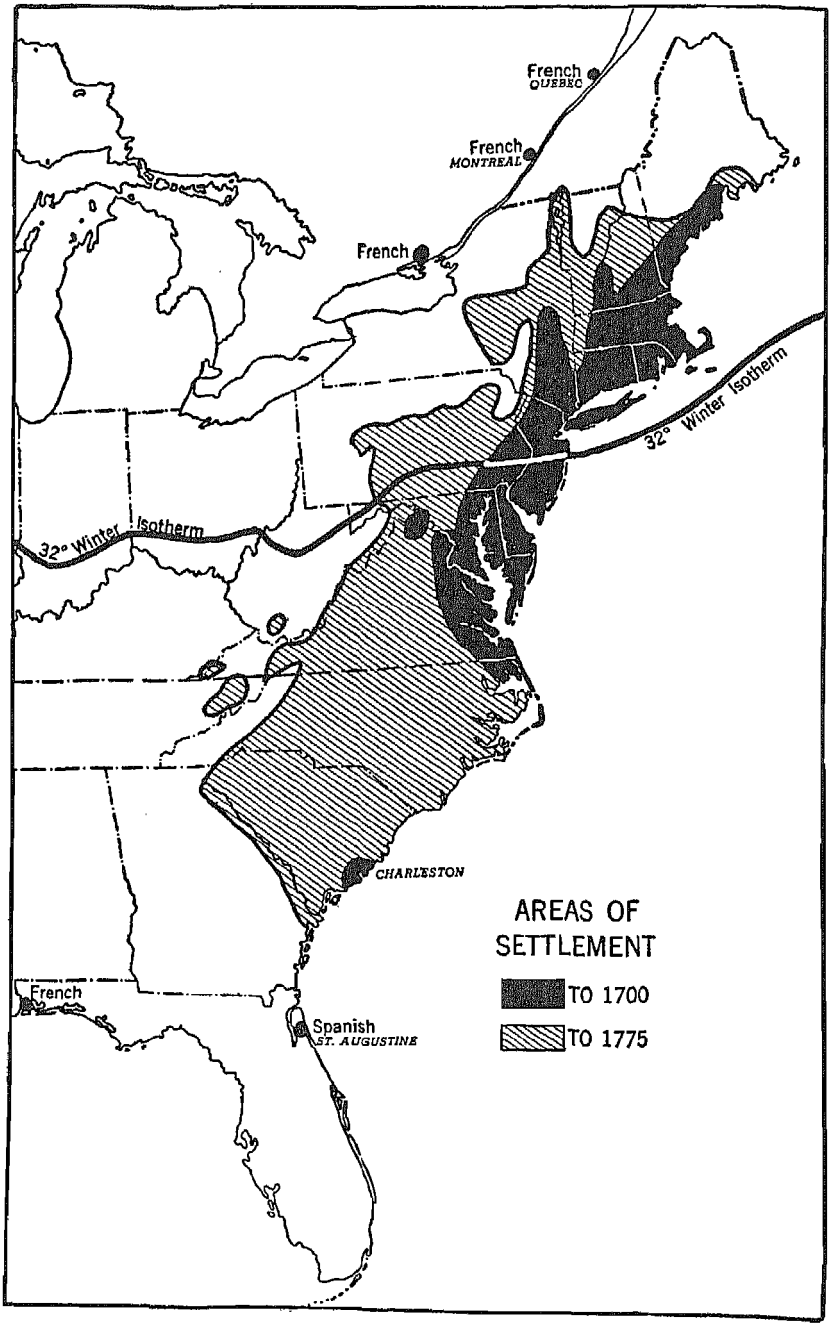
if not all of October, constitute the pleasantest season in Pennsylvania.[5]

It follows that with the limited heating apparatus of those days, the region most suitable for human energy was that now covered by south-eastern Pennsylvania, Virginia, Maryland, and Delaware. Virginia was larger than the other three areas combined, and almost from the start it proved to be the most populous and most successful colony. Small wonder then that from the earliest days until the more general adoption of the improved stove, and the cheapening and easy transportation of coal fuel, Virginia should have been, both intellectually and in size of population, the leader of the growing American colonies, and Philadelphia (in Pennsylvania) a great centre of discussion and source of stimulating influence. Seven of the first twelve Presidents were Virginians.

The coastal area had now been settled for over a century, and it is interesting to consider how the human stock was reacting to the various climatic conditions. As has already been pointed out, New England had winters of a severity unknown in England, and until heating devices gave it greater mastery over its winter, it remained a grim, aggressive, and well-educated example of British development. The Middle Colonies, however, had a more genial climate and the colonist developed a mixture of Northern hard-headedness with a sociability, hospitality, and tolerance that were unquestionably attractive. In general, life had an ampler quality than in New England, for, as Professor Allan Nevins has put it, 'The climate, the soil and the people were more genial.'[6]

In the South a non-industrial, cultured aristocracy and an aggregation of lesser planters and farmers lived in a semi-feudal state. Alongside of them was a lower class of 'poor whites,' and below these again the slaves, who in South Carolina outnumbered the whites two to one. The 'poor whites,' including 'a sizeable element of vagabondish, unenterprising and turbulent folk, who made lazy farmers and poor citizens,' deteriorated under frontier conditions and made up 'a body, illiterate, vulgar and shiftless,' who were, as Nevins says, 'despised even by the Negroes.' In due time science was to 'show

[5] Quoted in *Climate and Man*, p. 165.
[6] Nevins and Commager, *America, The Story of a Free People*, p. 40.



EARLY EUROPEAN SETTLEMENTS IN NORTH AMERICA
STATE BOUNDARIES ARE THOSE OF THE PRESENT DAY.

that climate, a defective diet and the hookworm' had far more to do with their slovenliness and waywardness than any 'innate faults.' William Byrd in his *History of the Dividing Line,* 1685, has described their laziness:

> Surely there is no place in the world where the inhabitants live with less labour than in North Carolina. It approaches nearer to the description of Lubberland than any other by the great felicity of the climate, the easiness of raising provisions, and the slothfulness of the people. The men lie and snore till the sun has run one-third of his course and dispersed all the unwholesome damps. Then, after stretching and yawning for half an hour . . . they venture into the open air; though, if it happens to be ever so little cold, they quickly return shivering to the chimney corner. When the weather is mild they stand leaning with both their arms upon the cornfield fence, and gravely consider whether they had best go and take a small heat at the hoe, but generally find reasons to put it off till another time. Thus they loiter away their lives, like Solomon's sluggard. To speak the truth it is a thorough aversion to labour that makes people file off to North Carolina, where plenty and a warm sun confirm them in their disposition to laziness for their whole lives.[7]

Of Virginia he adds, 'I am sorry to say it, but idleness is the general character of the men in the southern part of this colony, as well as in North Carolina.'

In that picture, perhaps humorously exaggerated, we see the germ of the poor-white problem that has affected the white races settled south of the 75° summer isotherm (or north of it in the Southern hemisphere) and of which there are such remarkable examples in South Africa and the West Indies, to which reference has been made in Chapter XI.

The War of Independence made little difference to the social habits of the Americans, but it moved the western boundary of the states from the Appalachians to the Mississippi, and it was followed by that drive towards the west which has been the most astonishing human trek in the history of the last 200 years. In 1803 the Louisiana Purchase flung the frontiers a thousand miles west, and the new states of Louisiana (1812), Mississippi (1817), Alabama (1819), Missouri (1821), and Arkansas (1836) were added.

[7] Published in *A Journey to the Land of Eden,* 1928, pp. 76-7.

The Americans and their new allies, the immigrants from Europe, now first came up against one of the greatest problems of all. Hitherto climate had been regarded as an asset of the growing American nation, but as the nation spread west and north greater extremes of climate were encountered, and the challenge had to be met. As early as 1742 Benjamin Franklin had planned a stove which was a great improvement on the earlier German patterns. In some districts the settlers had already taken advantage of local outcrops of coal, and there are references to its use by the Virginians along the James River in 1763. Anthracite was discovered in Rhode Island in 1760, in the Wyoming Valley in Pennsylvania in 1766, and in the Lehigh Valley about 1791. Illinois proved equally rich. From about the end of the eighteenth century these discoveries and improvements gave to Pennsylvania, New York, and New England a control over their winters such as the open-hearthed wood fire never gave.

In 1810 Virginia, whose boundaries then extended to the village of Chicago, was still the most populous state, but Pennsylvania was rapidly overtaking her, and New York was progressing faster than either. By 1830 their positions had changed:

	1800	1810	1820	1830
Virginia	1	1	2	3
Pennsylvania	2	3	3	2
New York	3	2	1	1

During the next century New York continued to be the most populous state. New York, one of the windiest places in the United States, sees the thermometer go below freezing point from November to March; during July and August few days pass without the thermometer exceeding 76° for an hour or two, and rain is heaviest during these two months. Broadly speaking, New York state and its neighbours, Connecticut and Massachusetts, are climatically more similar to Hungary than any other part of the globe, but the extremes are greater, and storms and rain are more evenly distributed throughout the year. In an area such as this, good climatic controls were of the first importance.

Meanwhile, kerosene and gas became an ally in the struggle

against dark and cold. Coal-gas lighting, economically developed by Murdock in England in 1802, was introduced about 1810, and was later supplemented by the natural gas, in which America has since been proved so abundant. At Fredonia in New York, natural gas was first turned to use in 1821, but it did not become greatly developed until 60 years later.

Meanwhile there was slowly evolving another invention which was to assist more than any since that of the chimney in controlling cold and damp—central heating. It is often thought that central heating is an American invention, but in its inception and early development it was as British as gas lighting. In 1608 Sir Hugh Platt of London suggested as 'a meer conceit' that a room might be warmed by hanging 'a cover of tin or other metal over the vessels wherein you boil your beef, which having a pipe in the top and being made in the fashion of a funnel, the heat may be conveyed into what place you shall think mete.' Over a century later, in 1745, Colonel William Cooke conceived a scheme of household steam heating by means of copper pipes running through all his rooms, and in 1784 James Watt applied such a scheme in his own home. Watt is of course more celebrated for his discovery of the steam-engine, but towards the end of his life he devoted much more attention to house-heating, and his last patent, 1785, was for a fuel-saving furnace.

The central heating of houses began about 1840. In that year a New Yorker, Joseph Nason, became a pupil of Angier Perkins in London. Perkins had developed a system of warming buildings by circulating hot water through small tubes. Nason, on his return to the United States, joined with J. J. Walworth, and the firm of Walworth and Nason, of 33 Ann Street, New York, may be said to be the originators and adapters of central heating in the United States. *The New York Journal* in 1841 contained an advertisement of the firm for 'wrought Iron Pipes and fixtures of all kinds for Water, Gas, Steam and Other Mechanical Purposes,' including the 'Perkins system of heating buildings by circulation of hot water, etc.' The pipes had been obtained from James Russell and Son, of Wednesbury, England. At that date there was no other firm in the United States doing business of this kind. Within a decade the Perkins-

Nason system had proved its worth and had set the pattern for house heating for a century.[8]

Thus by 1850, whilst no great improvement had been made in the control of the great summer heat of the southern states, the growing control of cold had been a great advantage to the north-eastern states. More than that, it was one of the factors in the pace at which the West was developed. As the pioneers pressed westwards through Ohio (1803), Indiana (1816), and Illinois (1818),[9] they found climatic conditions not dissimilar to those of inland Pennsylvania and New York, for the modifying influences of the Great Lakes extended from east of Rochester to west of Chicago. But when Michigan (1837), Iowa (1846), Wisconsin (1848), and Minnesota (1858) were opened up, more attention than ever had to be paid to the severity of the winters, which were only equalled by those of Canada and Maine.

In this development all the nations of Europe assisted. The Swedes and Finns, with their practical knowledge of how to deal with winters below zero, provided houses with double windows, double doors, and other kinds of heat-insulating devices. Greater and greater grew the demands for stoves, for coal, for gas, for anything that would conquer the piercing fury of the bitter winter cold.

But it was mainly the British emigrants to the United States who helped introduce the new methods, and by 1850 both railways and central heating were extensively used. Wherever the railway went it took coal, stoves, furnaces, radiators, and pipes to the new states which clamoured for them. By 1860 the length of railway in operation was 30,000 miles, and helped materially to open up the great central region.

Climatically this central region is one of strong contrasts, as is the interior of every great continental land mass. Winters are over 40° warmer in Texas than in the Dakotas, but the great thrusts of Canadian polar air may spill suddenly all the way down into the Gulf States. The growing season lasts only 3 to 4 months in northern North Dakota, 8 to 9 months in Texas;

[8] Information from the Carrier Corporation, Syracuse. See also further comments on Jacob Perkins, father of Angier Perkins, in the chapter on Air Conditioning, through the courtesy of the American Society of Heating and Ventilating Engineers.

[9] The dates given are those when the states entered the Union, i.e. when the population passed 60,000.

but midsummer days in the north may be almost as hot as in the south. Over the region in general, rainfall does not greatly exceed evaporation, so that drought is the chief hazard, but such rain as does occur usually comes in the early summer.

No other region of the earth of equal size (says Trewartha) is so well endowed physically—in surface configuration, soil, and climate—for agricultural use. Drought is the one serious natural handicap. Nevertheless, although the natural prairies provided superb grazing, during the three decades from 1850 to 1880 most of it went under the plough. To-day native prairie is almost a museum specimen. Never before in modern world history had white settlers entered into such a 'promised land' and never can they again, for no such frontiers remain. The occupying of the American prairies was an event of epochal significance for the nation and for the world.[10]

Pioneers from the East were for a time afraid of this flat, sunny, treeless land, where shade and water both were scarce, but they gradually evolved new methods of building and fuelling.

As settlement crept farther and farther west toward the Great Plains there was increasing dependence upon sod as a building material. The crudest form of house was an excavation in the side of a hill, with a front wall of cut turf or logs and a roof made of poles covered with grass and dirt sloping back to the hill. The sod house was not so quickly made but it was more satisfactory. To obtain the sod slabs for building, furrows were turned and cut into blocks about 3 feet long. These curious houses, although dark and hard to keep clean, were cool in summer and warm in winter and they could not be destroyed by prairie fire. Their average life was 6 to 7 years.

With his home built, the prairie settler had to take immediate steps to obtain fuel and water. Fuel was so scarce that firewood of the poorest quality often had to be hauled as far as 20 to 40 miles to a farm. Stove ovens were kept full of green cottonwood, drying it out to make it fit to burn. Later settlers even grubbed up the stumps. Buffalo and cow dung was also collected for fuel. Settlers were glad to let a cowboy bed his herd on their land, for this meant several pounds of cow dung.

[10] Trewartha, in *Climate and Man*, p. 172.

The most universal fuel on the prairies probably was dry grass twisted into knots called 'cats.'[11]

Once conquered, the prairies yielded enormously. No need here to grub out trees laboriously and endlessly; a man could have the land producing within a year. No need to think of conserving this soil—it looked inexhaustibly fertile. Eastward, great industrial cities were growing up that needed to be fed cheaply. The prairies, with cheap land and large-scale methods of production, could do the job. Quickly they swung into the production of wheat, corn, cattle, hogs on a vast scale; and to the south, cotton. Droughts, searing winds, insect plagues, blizzards took their toll, but they were incidents. The prairies were such an agricultural treasure as has seldom existed in the world, and they lived up to their destiny.[12]

But the pioneering axe and plough and the devastating forest fires rapidly upset nature's balance. The tide that rolled mankind forward from the Atlantic rolled back nature's mantle of forest and tall grass and bared a virgin land to the forces of wind and rain. The early colonist moreover had an illusion of everlasting abundance. As far as the eye could see in mountains or plains, there were illimitable lands to be conquered. Both in the original thirteen states, and in all the new ones, pitifully few attempts were made to conserve the precious soil. Wasteful as was this method of farming, it was not the result of ignorance. The French and German immigrants had known of terracing, afforestation, and good husbandry for centuries; British immigrants knew and tried hedging and ditching, and the creation of spinneys and copses for game. Alert farmers of all nationalities were fully alive to the need for checking the ravages of torrential downpours. As early as 1685 William Byrd described a deluge in Virginia which carried away tobacco hills 'with all the top of manured land.'

By 1769 George Washington, Jefferson, Randolph, and Edmund Ruffin devoted considerable time and attention to these problems of conservation, and by 1790 we have Patrick Henry, the radical Virginian, declaring 'since the achievement of Independence, he is the greatest patriot who stops the most gullies.'

But why should farmers care when over the next hill, or

[11] Dick, *The Sod-House Frontier*, pp. 255-60.
[12] Hambridge, in *Climate and Man*, p. 17.

across the next river, there was land better than that already ruined? Not until the beginning of the twentieth century (if then) did agriculture generally in the United States regard soil conservation as essential to good farming, and even then for thirty or forty years few of the best methods were put into practice.

For a time this westward expansion was checked by the Civil War. It has already been pointed out that the centre of power and influence had shifted north of the Mason-Dixon line about 1830; by 1860 it was clear that the states north of the 75° July isotherm (which is practically co-incidental with the Mason-Dixon line) were more populous, more energetic, and more ingenious than those south of it. The marshalling of the opposing forces showed that the North not only had great climatic advantages but also twice the man-power of the South, and an infinitely greater industrial capacity. The surprise is not that the North won, but that it took so long to win. The desperate courage of the South yielded at last. Had the war broken out half a century earlier (as indeed it might have done) it is possible that the South would have won. For decades the sore between the two halves of the United States was ulcerated further by the knowledge that the whole economy of the South, from Virginia to rainy Louisiana, seemed to be at a standstill, whilst the bounding, enterprising North went farther ahead. The South felt neglected, despised, and flouted, but all over the world areas similar to the South in climate were suffering or had suffered a like fate. The decay, decline, and defeat of Spain, Turkey, and Greece, and the rise of Germany and Japan showed that the sceptre was passing to those nations who had controllable climates and the means to control them.

For a time it seemed as if the lie would be given to this theory, for the most southerly state of all, excepting Florida (1845), was making history in no uncertain fashion. When Texas was admitted in 1845, one of the most productive areas in the United States was added to the Union. Texas has everything from oil to cattle, from timber to cotton, everything save only a controllable climate. In 1850 her population numbered 212,600—a mere sprinkling for a state larger than half-a-dozen of the older states put together. By 1900 Texas had reached the sixth place in population, with a figure just over 3,000,000.

Texas was prosperous. Fortunes were made in cattle and oil, and soon natural gas was added. Yet as we shall see later, while climate may be ignored for a time, eventually its influence is felt, and Texas to-day, with its sister states of Oklahoma, New Mexico, and Arizona, joins the Old South in showing symptoms of poverty and backwardness, which will be discussed more fully later. These four states have temperatures not dissimilar from those of northern Africa or the Balkans. Their basic population was Mexican, but is now mostly white, with nearly a million Negroes out of a total approaching five millions.

Meanwhile on the West Coast a new state vying with Texas in size had entered the Union in 1850. Like Texas, California has everything, from gold to the greatest harbour in the West, from the most fertile valleys in the States to deserts with the highest temperatures ever known in the New World. She has the highest land (Mt. Whitney, 14,746 feet) and the lowest land (Death Valley, 276 feet below sea level) and the lowest rainfall in the United States. More than all this, she has a coastal strip sometimes 50 miles wide unequalled in North America for the mild, serene salubrity of its climate.

The physiography of the state is simple: a mountain range runs along the coast with the startlingly beautiful Golden Gate of San Francisco breaking in not quite midway: another and vaster mountain system runs along the east border. The two ranges unite at their north and south ends and enclose a splendid valley of imperial extent with a climate very similar to that of Italy. Outside this valley, to the south-east, are the arid Colorado and Mojave deserts, the hottest part of the United States, not excluding Texas. The north-west counties are extremely wet, many localities having a rainfall of 60 to 70 inches, and along the entire coast north of Cape Conception night fogs are frequent. South of this point rainfall and humidity are extremely low. As one goes inland there are the widest divergences of climate. At many places the view may comprehend sea, mountains, and orange groves all at once, with a world-renowned aircraft factory or film unit to improve the picture.

Into this picturesque state in 1849 came the men of the gold rush. They found a pastoral country which had been tended

by the Franciscans and other Catholic orders for a century. In the pre-American era stock-breeding had been the principal industry, and hides and tallow were the sum and substance of Californian economy. In 1849 grass gave way to gold as the source of wealth; when the gold rush subsided, grain and wool took its place, and up to about 1900 California exhibited to the world the picture of a mechanized farming state. About 1900 fruit became king—fruit of a luscious magnitude that rapidly gave California a new world fame. In 1910 the Nestor Film Company opened the first movie studio in Hollywood, where there are 309 crystal clear days in the year and photographs can be taken the year round—an advantage only to be found elsewhere on the north-west coast of Morocco, south-west Africa, and a few other out-of-the-way spots.

The population grew from 93,000 in 1850 to 1,500,000 in 1900, and 8,000,000 in 1943. But the extraordinary thing is that in a state 800 miles long and 200 miles wide, half the population is concentrated in two small areas not more than 50 miles wide. Los Angeles, with its neighbours of Long Beach, Pasadena, etc., now has a population of 2,000,000; San Francisco and Oakland, with their satellites of Berkeley, San José, etc. have a population of just under 1,500,000. These two areas, together with a coastal strip running from Los Angeles to Oregon, have a climate as near the ideal as one could hope to find, as appears from the following figures:

	Average Temperature		*Relative Humidity*	
	Warmest Month	*Coldest Month*	*Warmest Month*	*Coldest Month*
Los Angeles area	71	55	54%	51%
San Francisco area	61 (Sept.)	50	59%	72%
Oakland area	64	47	57%	70%

These may be compared with the figures for the largest cities in New Zealand. There is one great hazard which no human ingenuity can overcome, that of earthquakes.

It must be borne in mind that when people speak about California they usually mean this narrow coastal strip; they seldom speak of Fresno or of places in the south-east, where the torrid heat is something equalled only in the Sudan or the Sahara, and the rainfall is less than 2 inches a year.

To the north of California, and enjoying an equally invigorating climate, are the newer states of Oregon (1859) and Washington (1889), but with this difference: that whereas the maritime influence in California extends only 50 or 60 miles inland, in Oregon and Washington the moderating sea influences cover almost the entire states and the rainfall is much higher. This coastal strip is the greatest single area in North America with a moderate controllable temperature the year round; Seattle, Spokane, Tacoma, and Portland have first-class climates from the point of view of mental and physical energy, similar to the best areas of Europe or Australia.

There is, of course, the utmost apparent difference between the climates of Los Angeles and Seattle, between Santa Barbara and Portland, for the southern cities are sunny and dry, and the northern cities cool and very rainy; but from the point of view of human endeavour, it is almost as good to be in one as the other. Each has its drawbacks, but all have climatic assets given to few other areas in the world.

Between the old United States, the Pacific Coast and Texas, there were now set up a dozen 'geometrical' states: Kansas (1861), Nevada (1864), Nebraska (1867), Colorado (1876), South Dakota, North Dakota, and Montana (1889), Idaho and Wyoming (1890), Utah (1896), Oklahoma (1907), and finally New Mexico and Arizona (1912).

Some of these leapt rapidly ahead. Kansas, Nebraska, and Oklahoma had all passed the 1,000,000 mark by 1905, but others, such as Nevada (the driest state), Wyoming, Arizona, and New Mexico, remained practically untenanted mountains or deserts, with less than one person for every 200 acres.

I have already pointed out that climatically the old United States could be divided into two distinct areas, the warm South and the temperate North, the dividing line being roughly along the 39th parallel in the east and the centre; but the New South, west of the Mississippi, is scarcely better climatically than the Old South, and the Pacific strip has a climate second to none in the world. The only remaining point to be dealt with is the quality of the climate in the aggregation of states between these three areas.

In this great region there occurs every year a series of dramatic struggles between heat and cold. The struggle may be said to begin with two high pressure areas far out at sea. One is in the northern Pacific. Here the polar air masses develop and storms come sweeping clockwise slowly across the continent from the north-west to the east and south-east. The other high-pressure region stretches from Bermuda to the Azores and pours warm moist air into the United States from the Gulf of Mexico and the southern Atlantic coast.

The cold air mass from Canada and the Pacific is normally stronger and its wind more violent than this warm air mass. By November the freezing dry cold has percolated south as far as the southern boundaries of West Virginia, Colorado, and Utah, and even farther south in the mountainous areas of New Mexico. Only the Pacific coastal area and the Gulf coastal areas are free from killing frosts. In the North, as winter advances, the cold increases until in Montana, North Dakota, and Minnesota large areas register a monthly average temperature of less than 10° F. in January, and even Chicago often sees the thermometer dip below zero. In mid-January more than half the United States suffers piercing cold.

After January the warm moist mass begins to advance, and month by month the polar airs are forced back, until, in July, New York, Chicago, and even parts of Montana suffer from stifling heat waves. In the West the Rockies act as an impregnable bastion, but in the Sacramento Valley of California the hot air seeps north up to the borders of Oregon. In July and August forty of the states of the Union swelter and perspire. A hundred million people seek shade and ice.

But with September the cold masses are on the move again, and by November the people of the North Central States are searching out their warmest clothing and getting ready for a winter that lasts four or five months. From the Rockies to the Appalachians the states prepare for blizzards and biting cold such as no part of Europe west of Warsaw experiences. The contest between the warm tropical and the cold polar air, which occurs during all seasons but is most evident during the cooler parts of the year, may be thought of as a continuous battle of weather along a shifting line known in meteorology

as the polar front. The attack of the polar forces is held close to the ground. When the opposing tropical breezes, constantly trying to reach the Canadian border, find their way blocked, they rise and overrun the polar mass, thus continuing the northward movement. The battle line therefore becomes not a vertical wall, but an inclined surface sloping upward toward the north. The two armies rarely battle to a standstill; rather, each southward thrust of cold air is balanced by a northward push of warm air. Thus the polar front is not normally a straight line but develops a series of large-scale waves. Because the polar front is in the region of prevailing west-to-east winds, the waves normally move eastward and bring alternating periods of warm and cold weather.[13]

A 'temperate' climate has been described as one where you freeze in winter and die of heat stroke in summer. That travesty is true of many areas in the United States. Indeed, with the exception of Canada, Russia, and Asia, no other part of the world can show such contrasts between summer and winter as the great central mass of states. In Kansas, perhaps the most central state of all, the temperature may vary from a high of 121° F. in July to a low of −23° in December or January. In Nebraska, which may dispute centrality with Kansas, the summer high in 1936 was 118° F. and the winter low −43° F. But South Dakota showed a greater range still, from 120° F. to −58° F. in 1936, a range of over 170° within the year.

The majority of the settlers in these new geometrical states had come from the Northeast, and, as has already been mentioned, previous experience had hardly prepared them for the drought hazards they now encountered. The initial settlement occurred during one of the rainier periods, and the settlers believed that the climate was becoming permanently more humid. In fact, many thought that it was the spread of cultivation that brought about an increase in rainfall. Aughey, in writing about Nebraska in 1880, said:

> After the soil is broken, a rain as it falls is absorbed by the soil like a huge sponge. The soil gives this absorbed moisture slowly back to the atmosphere by evaporation. Thus year by year as cultivation of the soil is extended, most of the rain that falls is ab-

[13] Holzman, in *Climate and Man*, p. 552.

sorbed and retained to be given off by evaporation, or to produce springs. This, of course, must give increasing moisture and rainfall.[14]

This scientific illusion was destroyed by the drought of the nineties. Immigration stopped; indeed there was instead a considerable emigration. In some parts of western Kansas, two-thirds of the farm population was forced to leave because of drought. Many towns were completely abandoned, and 2,000 geographical names disappeared from the map. One reaction to the drought was a great increase in dry farming. The result was an increasing deterioration of the soil and the introduction of wind erosion as an added curse. Thirty years later the First World War, with its high prices for wheat, and a few rainy years brought prosperity to the Plains again.

Then during the 1930's there were droughts, coming on the top of the Depression. Once more great numbers of people were ruined and forced to emigrate. Meanwhile more of the best soil had vanished forever and Oklahoma, Kansas, and Nebraska had become the Dust Bowl.

When the United States did wake up to the problem it was almost too late. For the history of the attempts to control erosion the reader should see *Soils and Men,* pp. 602 seq., but the ineffectiveness of the methods used may be gauged by the fact that in three states where terracing had been practised, agricultural engineers found over 96 per cent of existing terraces 'unsatisfactory.'

In 1934 the United States Department of Agriculture carried out a great reconnaissance survey. According to this, of the 1,903,000,000 acres that make up the United States, approximately 144,768,000 acres, or about 7½ per cent, are mountains, mesas, canyons, or bad lands. All the rest was of use to man for crops, forests, or pastures. Only 37 per cent (700,500,000 acres) of the total land area was unaffected by erosion, bad farming practices, etc. On over 41 per cent of the land, erosion had caused the loss of approximately half of the top soil, and on 15 per cent erosion had been so severe that over three-quarters of the original surface soil had been lost. All this had come about within a century, since the Atlantic

[14] Aughey, *Sketches of the Physical Geography and Geology of Nebraska,* pp. 44-5.

and New England coast and the Mississippi Valley areas are the regions most lightly affected.

The present cropland area amounts to just over 400,000,000 acres. Of this practically 60 per cent is either subject to continued erosion or now of such poor quality as not to return a satisfactory income to farmers at normal prices. Some 3,000,000,000 tons of soil yearly are washed or blown into rivers, reservoirs or oceans. The chemicals carried into rivers, lakes, or the sea annually represent more than 60 times the amounts used in fertilizers in 1934. If not checked, erosion will take all, leaving great areas in the southern and central United States as the archæologists now find the sites of former cities in Palestine and Iran.[15]

But the scourge does not stop with the soil. In irrigated areas where reservoirs become silted up, there is rural migration or unemployment, the tax basis is disrupted, the overhead expenditure of states and countries increases, whilst industrial markets decline.

Since 1934 the United States Government has been tackling the problem on a nation-wide basis. Hundreds of thousands of acres had been reforested by 1940, but land was being released from agriculture at the rate of over a million acres a year (making a total of 80 million acres by 1940). What the position has been since the outbreak of war is difficult to say, but I think it is beyond question that under the stern necessity of producing more food, the bulldozer, tractor, and axe are being used as never before.

There are many causes for this serious state of affairs—from tenant farming to defective education; possibly not the least of them is the effect of climate on man's energy and thought. It is interesting in this connection to consider a biological experiment carried out from 1909 to 1911 with wheat. In 1909 agricultural investigators in Kansas, California, and Maryland exchanged samples of soil, and over a three-year period grew exactly the same wheat in exactly the same soil. The only divergent factor was climate. The result was a marked difference in the content of protein, mineral ash, phosphoric acid, and potash. Wheat grown on Kansas soil in Kansas produced 18.73 per cent protein, but Kansas soil in California produced only

[15] *Soils and Men*, pp. 595 et seq.

10.6 per cent protein and California soil in Maryland 10.27 per cent. Other analyses produced equally surprising results, and one of the main conclusions was that the influence of locality (i.e. climate) compared with the soil was as three to one.[16] A similar experiment with sugar cane in localities only 3½ miles apart, but one 500 feet higher than the other, showed the overwhelming influence of climate on the production of sugar. Now any gardener in England can parallel these experiments by comparing the tomato plant inside or outside the greenhouse, or by sunny or shady walls. If climate be shown to have so strong an effect on wheat, sugar, or tomatoes, surely its effect on men, who are a staple factor in agriculture, should be taken into account.

It may be pertinent to point out that many animals reflect the influence of climate in no uncertain manner. Pedigree bulls and rams imported from Europe into the southern states lose their vigor in a surprisingly short time, but a limited experiment carried out by Dr. Bowage, mentioned in *Soils and Men,* shows that where these pedigree animals had air-conditioned stabling they retained their virility unimpaired.

This is not the place to go further into the question by assessing the results of climate on man, but it is evident that climate has a profound effect on all living things and that man is not excluded from its force. If parts of the United States have climates comparable with parts of Russia or North Africa, we should bear in mind the lessons of history.

In concluding this brief historical sketch of the United States, reference must be made to the industrial revolution which followed the Civil War. Many observers indeed regarded this war as a struggle between King Cotton and King Wheat rather than as a struggle between an expanding agriculture and a rising industrialism. The next few decades saw the United States become the greatest industrial nation of the world, with the farmer in danger of becoming a peasant.

A glance at an industrial map of the United States shows that the great coal and iron areas stretch from Pennsylvania to Alabama and the new industrial area might conceivably have stretched from North to South. But as has been brought

[16] Ibid. p. 788.

out in the chapter on the British Isles, mobile industries will gravitate to the best climatic areas. The result was that whilst great geographical industries did spring up as far south as Birmingham, Alabama, the mobile industries and the financial and directing centres were all, with very few exceptions, in the Great Lakes-Atlantic area, and it is this area in which the climate of the eastern United States is most controllable the year round. Even when oil came to challenge coal, the directing centres were not in Texas, Oklahoma, or Kansas, but in the Northeast.[17] It is fascinating to plot, on an industrial map of the United States, its geographical industries, and then the offices or private residences of the chiefs who control them. It is equally fascinating to see how the mobile industries have gradually moved with an ever-growing density into the Great Lakes-Atlantic area. The automobile and engineering industries might have sprung up anywhere in the United States, and indeed there were a few ventures in the South, but they developed and succeeded in an area where climatic controls were most effective.

All this, of course, was while California, Oregon, and Washington were in their infancy of development; but after the First World War this region began to assume a much greater importance, and to attract some of the best brains of the United States and Europe. Its future course will be considered in a later section.

II

Meanwhile with the turn of the century there were distinct signs that the American promise of life was not being fulfilled. Americans were better off than contemporaries overseas, and their material achievements impressive, but there were also disquieting symptoms. As President Wilson said in his first inaugural address (1913):

> Evil has come with the good . . . We have squandered a great part of what we might have used, and have not stopped to conserve the exceeding bounty of nature . . . We have been proud of our industrial achievements but we have not hitherto stopped thoughtfully enough to count the human cost, the cost of lives snuffed out, or energies overtaxed and broken, the fearful physical

[17] It should be noted that oil was first struck in Pennsylvania in 1859.

and spiritual cost to the men and women and children upon whom the dead weight and burden of it all has fallen pitilessly the years through.

In those early years of the twentieth century immigrants poured in faster than they could be absorbed, slums grew apace, factory production exceeded consumption, and 'malefactors of great wealth' grew so rich that they scarcely knew what to do with their money. Edwin Markham discovered 'The Man with the Hoe,' and American 'civilization' was condemned by politician, parson, and poet. The city, says James Bryce in his *American Commonwealth,* was the only conspicuous failure of American democracy.

Great efforts were made by reformers to check abuses, but as in the realm of agriculture so in the realm of industry problems of vast magnitude persisted. A quarter of a century later Henry A. Wallace (November 1939) said, 'Without a great movement for conservation our much vaunted modern civilization will in time be plunged into decadence and lower standards as have befallen other great nations in the past.' Certainly the depression of 1929-35 was the worst in history, and at its depths there was a Federal Survey of 'Six Rural Problem Areas,' which is perhaps one of the most significant documents ever produced by the United States Government. The Six Areas include most of the south and centre, i.e. those areas in which according to the climate we might legitimately expect the 'poor white' problem to appear. They comprised the cotton belt and west, extending thence up the centre including the Appalachians and Ozark hills and forming a broad central belt from Canada to Texas. In these areas 'the plight of the residents steadily worsens, especially in the Appalachian area' (which had been longest settled of all the areas chosen). 'Thousands wander, doing casual work and earning up to $200 a year. Others bivouac in old cars in places like the San Joaquin Valley, where they exist without homes or sanitation, dependent on Federal relief, spreading disease. 1,800,000 souls require rehabilitation.'[18]

'The South is distinguished by an extreme and perennial poverty in comparison with the rest of the continent,' contin-

[18] Quoted by Kenneth White, *Labour and Democracy in the United States,* 1939.

ues White. 'The near peonage which has taken the place of economic slavery, and the social degradation of the labouring masses render the region almost a foreign country to those who live north of the Mason-Dixon line, and class it with areas of extreme imperialist and racial exploitation such as we normally look for in India and Africa.'

The story is continued by the United States *Year Book of Agriculture*, 1943, p. 882:

> 1,000,000 of our rural families were living in homes not fit for human beings. 70 per cent of our farm houses lacked a kitchen sink with a drain; only 1 in 10 had an indoor toilet . . . hookworm, malaria and pellagra contributed to what was called laziness in many parts of the South . . . the farm population was trying to rear and educate one-third of the nation's children on one-tenth of the national income. An ugly picture.

There is plain evidence that on over a fifth of the land the poor-white problem was developing in pre-war years and in my opinion climate and lack of climate controls are major contributory factors to this distressing trend in the United States.

Before, however, we assess these trends in statistical detail, let us consider the climate of the various states, so that we can understand more completely the climatic handicaps under which 40,000,000 Americans work and live.

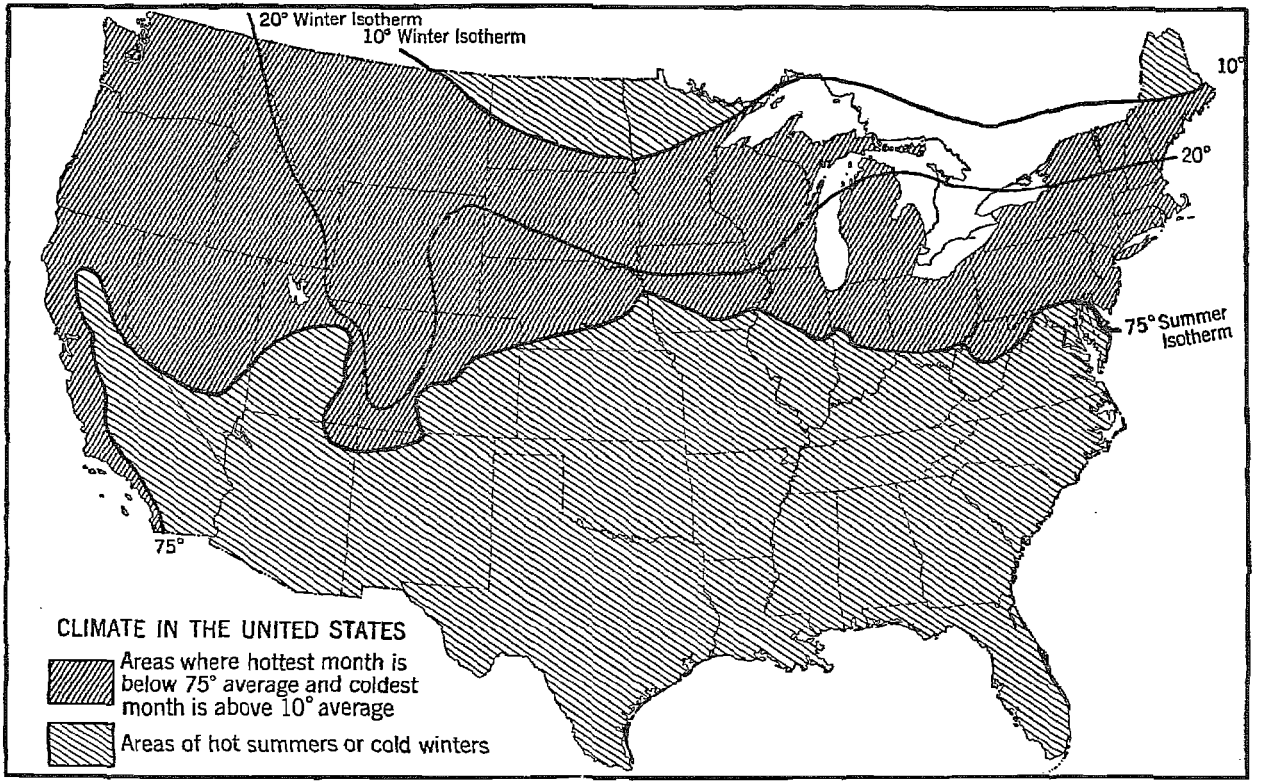
XIV

THE UNITED STATES: CLIMATE AND ENERGY

In previous pages, when considering the climate of the various states I have referred to the extreme temperatures reached in areas like Death Valley, or South Dakota, or even Chicago. But these represent extremes which may be reached at most only for an hour or two during the year, and for the purpose of this work the important climatological conditions are not those freak occurrences which form the subject of banner headlines in the press, but rather the average conditions under which men work or play. Of these, average monthly statistics give a fair idea.

The United States is so vast that there can be no question of average figures for the whole country, and indeed even those for groups of states may give a false impression. Therefore it is better to take the conditions in each state. In reckoning these I have taken as my basis the records for the populated areas; thus in Wisconsin the average January temperature for the whole state is 15° F., but for the most densely populated area (i.e. the Milwaukee area) it is 20° F. The full list is given in Appendix III.

According to the theory previously advanced, we should expect to find civilization and energy at their highest in those states which enjoy an optimum climate, i.e. in the Pacific coastal strip and the Great Lakes-Atlantic area, and at their lowest in those states which have a hot humid climate, or great extremes of temperature, provided that the population there is indigenous to the state. We find, however, that in at least a dozen states the bulk of the population is neither native to the state, nor does it consist of people who have spent their early years in that state. In Arizona, for example, only 25 per cent of the population are native born, and in Nevada, Wyoming, and California only about one-third. It is obvious that in any state where the bulk of the population consists of new-


20° Winter Isotherm
10° Winter Isotherm
10°
20°
75° Summer Isotherm
75°
CLIMATE IN THE UNITED STATES
Areas where hottest month is below 75° average and coldest month is above 10° average
Areas of hot summers or cold winters

comers, the population will represent not so much the native energy of that state as an indefinable mixture of all states, and may even have a large foreign element. New York, Massachusetts, and Connecticut have about 25 per cent of European or Canadian immigrants.

We must therefore regard the vital and industrial statistics of some states with a certain amount of caution, since they may reflect not the energy of the state itself but the energy of immigrants from other areas. This question will be dealt with more fully later on.

With this warning in mind, let us take the climatic statistics of the various states given in Appendix III and arrange them in two groups:

I. Those states with moderate summers, i.e. where the average temperature of the hottest month does not exceed 75° F.

II. Those states with one or more months of an average temperature exceeding 75° F.

It must of course be borne in mind that these assessments are of the most densely populated parts of a given state. They are based on county reports as given in *Climate and Man*.[1] The temperatures reported for each county have been weighted according to the population of that county, thus giving the closest available picture of the actual temperatures under which people live.

TABLE I

STATES WITH NO MONTH WARMER THAN 75°, ARRANGED IN ORDER OF COLDEST MONTH

	Average Temperature	
	Coldest Month	*Warmest Month*
North Dakota	6° F.	69° F.
Minnesota	11° F.	71° F.
Maine	17° F.	68° F.
South Dakota	16° F.	74° F.
Vermont	18° F.	68° F.
Wisconsin	18° F.	71° F.
Montana	20° F.	65° F.
Wyoming	21° F.	68° F.
New Hampshire	21° F.	69° F.

[1] *Climate and Man*, 1941 Yearbook of Agriculture, Washington, 1941.

	Average Temperature	
	Coldest Month	*Warmest Month*
Iowa	21° F.	74° F.
Michigan	24° F.	72° F.
Illinois	24° F.	74° F.
Idaho	26° F.	68° F.
Utah	27° F.	74° F.
Colorado	28° F.	70° F.
Massachusetts	28° F.	71° F.
Connecticut	28° F.	72° F.
Ohio	28° F.	73° F.
New York	29° F.	73° F.
Rhode Island	29° F.	73° F.
Nevada	30° F.	73° F.
Pennsylvania	30° F.	74° F.
New Jersey	31° F.	74° F.
Washington	35° F.	65° F.
Oregon	39° F.	67° F.
California	51° F.	70° F.

TABLE II

STATES IN WHICH ONE OR MORE MONTHS HAVE AN AVERAGE TEMPERATURE ABOVE 75°, ARRANGED IN ORDER OF WARMEST MONTH

	Average Temperature		*Number of Months Above 75°*	
	Coldest Month	*Warmest Month*	*State **	*Largest City*
West Virginia	34° F.	75° F.	1	1
Nebraska	24° F.	76° F.	1	1
Indiana	29° F.	76° F.	1	1
New Mexico	34° F.	76° F.	0	1
Delaware	34° F.	76° F.	1	1
Maryland	34° F.	76° F.	1	2
Virginia	36° F.	76° F.	1	2
North Carolina	41° F.	77° F.	2	3
Kentucky	35° F.	78° F.	2	2
Missouri	32° F.	79° F.	2	3
Tennessee	40° F.	79° F.	2	3
Kansas	31° F.	80° F.	2	2
Arizona	42° F.	80° F.	2	5
Georgia	48° F.	80° F.	4	3
Alabama	46° F.	80° F.	3	3
South Carolina	46° F.	80° F.	3	4
Arkansas	42° F.	81° F.	3	3

	Average Temperature		*Number of Months Above 75°*	
	Coldest Month	*Warmest Month*	*State* *	*Largest City*
Mississippi	47° F.	81° F.	4	4
Oklahoma	39° F.	82° F.	3	3
Louisiana	53° F.	82° F.	4	5
Florida	63° F.	82° F.	5	6
Texas	49° F.	83° F.	4	5

* These figures represent the averages for the entire state as given by the U. S. Weather Bureau, regardless of the distribution of population. New Mexico, Arizona and the mountain states are much warmer than the figures suggest owing to the intensity of solar radiation in high altitudes. See p. 65 supra.

In the first table the states have been arranged according to the temperature of the coldest month, beginning with the lowest. In the second, the arrangement is according to the temperature in the warmest month, with the lowest temperature first. Thus at the beginning of the first table and at the end of the second we have states which suffer from extremes of temperatures. Among the six coldest states, North Dakota and Maine often show up poorly in statistical tables. The others, however, include some of the states that are considered most progressive, such as Minnesota and Wisconsin. Inasmuch as North Dakota suffers from drought as well as low temperature, and is one of the most purely agricultural states, its deficiencies can only in part be attributed to low temperature. Some other states, such as Maine, with temperatures considerably higher than North Dakota, show a similar tendency to fall below their neighbours in many respects, such as health, production, and general level of progress. It may be that Maine has been drained of many of its more active people through immigration to the west.

For our present purposes, the second table is much the more important. This includes all the southern states, together with a group of states in the very heart of the country. These excessively continental states—Nebraska, Indiana, Missouri, and Kansas—have rather cold winters and very hot summers.[2] Farther east the summer heat is debilitating because it is more often

[2] Illinois would fall in this group except for the great concentration of its population around Chicago.

humid. This may be one reason why Indiana often falls below its neighbours in some of the important elements of progress. In the remaining states of the second table, many of the economic and social difficulties apparently arise from the debilitating effect of the hotter months. Studies of fatigue in England and various experiments at the laboratory of the American Society of Heating and Ventilating Engineers in Pittsburgh indicate not only that high temperatures slow down people's work, but that recovery from their effect is slow. In American factories Huntington found that the level of work in the autumn seems to be considerably affected by the degree to which summer heat has previously lessened people's activity. In Japan the same thing is evident. There the hot summer brings the highest death rate in September at just the time when it is lowest in places with more favourable summers. Factory workers at that time drop to the lowest level in hourly output. Such conditions would not prevail if man had learned to control high temperatures.

The contrast between our control of low and high temperatures is illustrated by the fact that in North Dakota, even though the average temperature for day and night together in January is only 6° above zero, man's technical skill enables him to keep reasonably warm. On the other hand, even in such states as Missouri and Indiana, the overwhelming majority of people have as yet adopted no efficient means of preventing themselves from feeling too hot during the summer months. Curiously enough, people complain of the heat much more in such cities as Louisville and Indianapolis, where excessive temperatures last only a month or two (last column on page 225), than in New Orleans, where the hot season lasts 4 months, or in Houston, where it lasts 5. The people of the southern states have apparently become so adjusted to the hot weather that they do not suffer so much as do the more northern people. The inhabitant of Kansas, Missouri, or Indiana normally works at a pace which is too fast for his hot summer. The native of Louisiana, Texas, or Florida, on the other hand, has acquired a life-long habit of acting more slowly than the Northerners, so that he does not suffer so much from the heat and perhaps would say that he enjoys it. The central point is

that man adjusts himself to a rate of activity appropriate to the combined effect of the natural climate in which he lives and the artificial climate which he creates.

In this connection two things are perhaps ominous for the United States. One is that no less than 22 states out of 48 have from 1 to 5 months of the kind of weather which almost inevitably will continue to make people relatively slow until some means of correcting it is found. Perhaps air-conditioning will do the trick, but thus far the mitigation of the effect of heat has been much more difficult than that of cold. Moreover, we cannot change the outdoor temperature, and people are bound to be out of doors a great deal in hot weather. This has a further implication when one considers the intensity of sunshine at high altitudes, as in Arizona, New Mexico, and the Mountain States. At elevations over 4,000 feet, the rarefied air presents far less an obstacle to the sun's rays than the denser air at lower altitudes. Consequently whilst the shade temperatures in these states may appear moderate, the feel of the air and sun out of doors is quite different, since 60° in the shade may be 120° in the sun, and shade temperatures give us no clue to actual conditions of comfort or human energy. I can only repeat that the ideal climate is one in which man neither shivers nor perspires when at rest.

A historic comparison between the states with summer temperatures above and below 75° brings out some interesting relationships. It is clear that the South, that is, the states comprising most of the second table on page 178, was dominant during the first half of the history of the United States, and that the cooler states have been dominant during the second. This is in accord with the general historic development. In colonial days the South out-ranked the North in many respects. Virginia, especially, stood high in culture as well as in population, and its leadership was universally acknowledged. A surprising number of the great names in American history belong to men born in Virginia. Washington and Jefferson head the list. Abraham Lincoln was also a Southerner, having been born in Kentucky. Among the first 12 Presidents, 7 were Virginians, and three others came from the Carolinas. Superior wealth and population helped Virginia, as did the

innate ability of her sons. Nevertheless, a real part may have been played by the fact that in colonial days the Northerners had not yet learned how to control the rigour of their winter climate. Thus when the natural climate and the artificial climate were taken together, the Virginians were probably more favoured than anybody else in America prior to the advent of central heating and electricity.

Another point is worth considering in this connection. There is considerable evidence that the climate of all parts of the world fluctuates in long cycles. On the whole, in recent decades there has been a tendency toward higher temperature in North America. A record dating back to 1780 shows that New Haven, for example, had its coldest twenty years from 1855 to 1874. From that time up to the twenty years ending about 1939, the general tendency was upward, in spite of great irregularity from year to year. The change from the earlier to the later twenty years was as great as if New Haven had been moved southward as far as Atlantic City, or even as Wilmington, Delaware. A similar change has been widely observed elsewhere. There is no assurance that this will be permanent. It may be due to fluctuations in sunspots or some other natural cause which produces long cycles.

Another aspect of climatic cycles is that during the 1930's, the United States experienced the greatest drought since records were kept. At that time, as we have stated earlier, the great area known as the Dust Bowl, especially in Oklahoma, Kansas, and neighbouring states, reverted almost to the condition of a desert. In other parts of the country such periods of dryness have a very bad effect upon crops and also upon the erosion of the soil. They may be only temporary and their effect may be reversed as the sun changes its condition. Nevertheless, every change in the direction of rising temperature and reduced precipitation increases erosion, forest fires, and the general destruction of vegetation; and the destruction of vegetation in turn increases all those agencies which assist in its further destruction. It is difficult to see how the United States can get out of a vicious spiral of desiccation, erosion, and decay without tremendous efforts. Meanwhile there is some excuse

for those who feel that in Tennessee or New Haven the summers are warmer than in Granddad's day.

TESTS OF HEALTH, WEALTH AND CULTURE

And now let us survey the various tests of civilization in the United States in the following order:

A. Infantile mortality (Health statistics)
B. Intelligence and culture (Tests by states)
C. Income per head (Trade statistics)

We shall then summarize the results to see whether energy and civilization as indicated by these tests agree or not with our climatic map.

A. INFANTILE MORTALITY

During three successive periods extending from 1930 to 1940 the infantile mortality per 1,000 births in the several states was as follows. The states are arranged in order of merit according to the figures for the latest period.

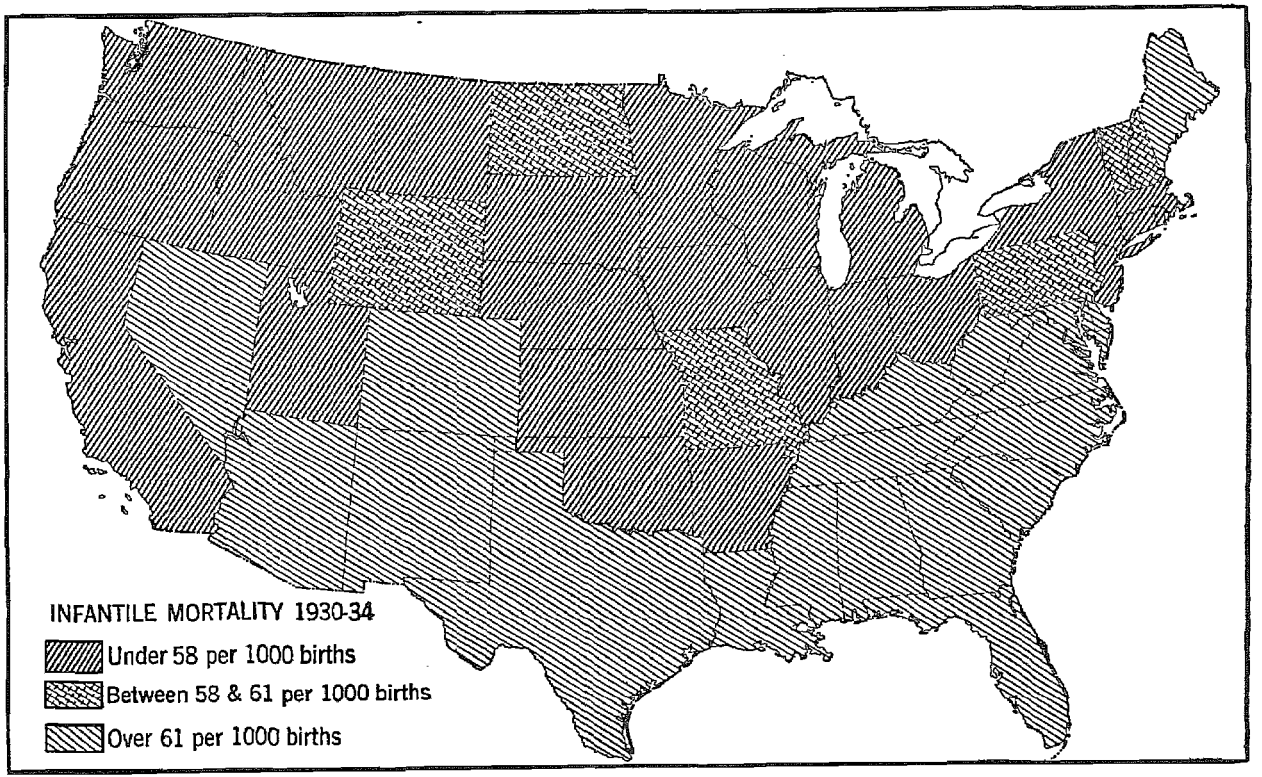
	1930-34	1935-7	1938-40
Connecticut	51	41	35
Oregon	43	42	36
Nebraska	47	43	36
Minnesota	49	44	36
Washington	45	43	37
New Jersey	52	43	38
Illinois	54	45	38
Iowa	50	47	38
Massachusetts	54	46	39
New York	55	47	39
Rhode Island	58	48	40
Kansas	50	49	40
Wisconsin	51	45	40
California	55	52	41
Indiana	56	51	41
Michigan	55	49	42
South Dakota	55	51	42
Utah	50	48	43
Pennsylvania	60	51	43
Idaho	51	49	44
New Hampshire	59	50	44

	1930-34	1935-7	1938-40
Vermont	59	52	45
Nevada	69	60	46
Montana	55	57	47
Missouri	59	57	48
North Dakota	59	54	48
Arkansas	51	51	49
Ohio	57	51	42
Wyoming	60	55	49
Oklahoma	56	57	49
Delaware	69	65	49
Maryland	72	64	51
Maine	69	64	53
Mississippi	61	57	55
Kentucky	63	62	55
Florida	64	61	56
Tennessee	71	65	57
West Virginia	74	65	57
Colorado	78	73	58
Alabama	65	64	60
North Carolina	72	68	61
Georgia	71	67	61
Virginia	73	71	62
Louisiana	68	69	64
Texas	74	72	67
South Carolina	82	79	72
Arizona	107	117	93
New Mexico	132	124	105

The first important conclusion from this list is that, aside from Arkansas, all the southern states, from Florida to Arizona, are in the lower nineteen. The only really northern intruder in the lowest third is Maine.

The second important conclusion is that the states on the Pacific seaboard and in the Great Lakes-Atlantic area are among the leaders. The only anomalies are Minnesota, Nebraska, and Iowa, which appear among the first eight. It is here that we must consider the influence of immigration on infantile mortality.

Dr. W. H. Guilfoy of New York City made an intensive inquiry into this about 1920, when 13 per cent of the entire population of the states was foreign-born. He showed that the nationality of the mother seemed to be one of the predominant factors in infantile mortality. His figures for 1919 are of interest:



IF THIS MAP WERE EXTENDED TO INCLUDE CANADA, BRITISH COLUMBIA AND THE ONTARIO PENINSULA WOULD BE IN THE BEST (I.E. LOWEST) AREA.

INFANTILE MORTALITY RATES ACCORDING TO COUNTRY OF BIRTH OF MOTHER, 1919 AND 1925, PER THOUSAND BIRTHS

	Guilfoy 1919	*Census* 1925
General rate for United States of America	86.6	71.7
Denmark, Norway, Sweden	66.8	55.6
England, Scotland, Wales	73.2	61.2
Russia	73.6 *	55.4
United States (white)	77.7	64.9
Germany	78.1 *	62.9
Ireland	87.4	73.9
Italy	87.7	69.9
Hungary	89.3	82.8 †
Canada	99.1	80.8
Other foreign countries	104.8	94.6
Austria	112.6 *	82.8 †
Poland	124.4	93.6
Negroes (U.S.)	134.3	112.0

* Includes Russian, German, and Austrian Poland respectively.
† Hungary and Austria.

These findings have since been corroborated by the Census of 1925. Since the upbringing of the mother has an obvious influence on infant welfare, it is worth remembering that no less than ten states in 1930 had less than 50 per cent of their population born within the state, namely:

	Per cent
Arizona	25.4
Nevada	29.8
Wyoming	32.0
California	33.9
Washington	35.9
Oregon	39.8
Idaho	42.7
Florida	46.4
Oklahoma	47.4
Colorado	40.2

It follows that in states such as these the infantile mortality figures may reflect not so much the climate of the state, but that of the state or country in which the mother was born and spent her formative years.

Unfortunately I have not the figures that would permit me to dissect these figures by states, but I have the figures giving the percentage of foreign-born whites in the several states, and

these bring out the curious fact that where the proportion of Scandinavian, Dutch, and English immigrants is at its greatest, infantile mortality is at its lowest. States with a high percentage of Mexicans or Negroes are among those with the highest mortality.

In most states the foreign mixture is such that north-western Europeans are equalled by southern or eastern Europeans. California, for example, had 144,000 immigrants from the British Isles and Scandinavia, 82,000 from Germany, and 200,000 from the rest of Europe. But Minnesota had 200,000 British and Scandinavians compared with only 33,000 from Russia, Poland, and Italy; 65 per cent of her population were native-born, 19.6 per cent from other states, 9 per cent from the British Isles and Scandinavia, 3 per cent from Germany and 3 per cent from the rest of Europe. Nebraska had 70,000 from north-west Europe (33,000 from Scandinavia) and only 30,000 from the rest of Europe, while Iowa had 117,000 from north-west Europe and under 20,000 from the rest.

It follows, therefore, that since Minnesota, Iowa, and Nebraska have a very high proportion of immigrants from the best climatic areas of Europe they may show better infantile mortality figures than their neighbours for some years to come.

New York is the greatest melting-pot in the United States, and here 637,000 from the British Isles and Scandinavia, and 350,000 from Germany contrast with 1,700,000 from the rest of Europe. We may reasonably expect, therefore, that New York would reflect a slightly worse figure than her climate would suggest.

Allowing for these minor modifications, it is evident that there is a very high degree of correspondence between the climates of the various states of the United States and their infantile mortality statistics.

B. INTELLIGENCE AND CULTURE

No assessment of a nation's energy is or can be complete without some assessment of its culture or intelligence. Health statistics may prove the suitability of an area as far as the body is concerned, and industrial statistics may prove the extent or

suitability of the country's natural resources, but intelligence or culture is in a different category.

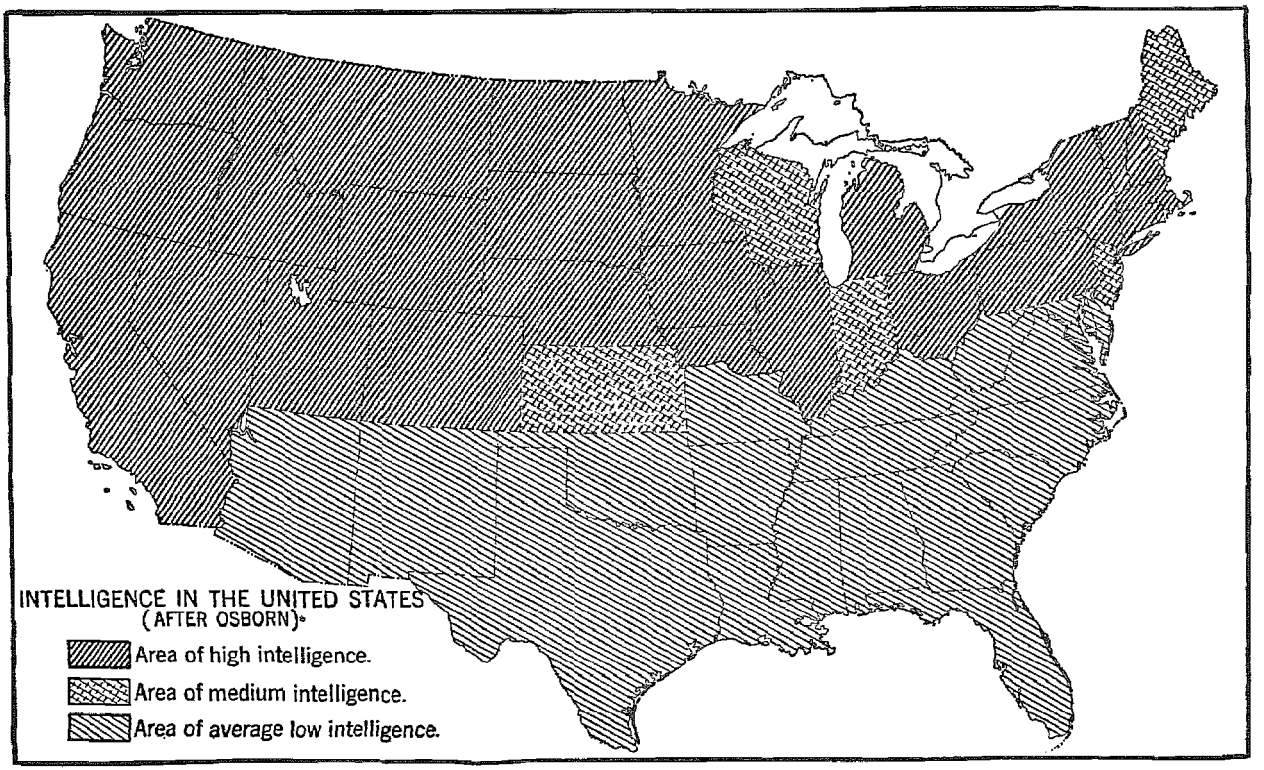
Possibly the best study ever carried out in this connection is that by Frederick Osborn of the American Museum of Natural History, who in 1933 produced an 'Index of Cultural Development' for the various states based on

(a) Mental tests among school children
(b) Army intelligence tests
(c) Illiteracy percentages
(d) Magazine readers per 100 total population
(e) School teachers' salaries
(f) Library statistics.

Taking the complete results based on the different tests, his figures show that the State of Washington was first with a score of plus 9.03, while California ranked second with 8.92 and Massachusetts third with 8.83. New York ranked thirteenth with plus 3.51.

The complete order of the states with their scores was found to be as follows:

Washington	9.03	Maine	1.95
California	8.92	Wisconsin	1.75
Massachusetts	8.83	New Jersey	1.31
Oregon	8.69	Kansas	0.83
Connecticut	7.53	Indiana	−0.25
Wyoming	5.31	Arizona	−0.40
Colorado	5.30	Maryland	−0.58
Vermont	5.24	Florida	−0.94
Montana	5.10	Missouri	−1.75
Ohio	4.73	Delaware	−2.17
New Hampshire	4.42	West Virginia	−3.69
Minnesota	3.51	Virginia	−3.77
New York	3.51	Oklahoma	−5.66
Rhode Island	3.34	Texas	−6.18
North Dakota	3.23	New Mexico	−6.60
Iowa	3.12	Kentucky	−7.16
Utah	3.08	Tennessee	−8.22
Idaho	2.88	Alabama	−8.82
Nebraska	2.88	Georgia	−9.19
Michigan	2.85	South Carolina	−9.29
Nevada	2.72	North Carolina	−9.35
Illinois	2.61	Arkansas	−9.92
South Dakota	2.51	Louisiana	−10.90
Pennsylvania	2.14	Mississippi	−10.92


INTELLIGENCE IN THE UNITED STATES
(AFTER OSBORN)
Area of high intelligence.
Area of medium intelligence.
Area of average low intelligence.

In these tests, as in the infantile mortality test, the southern states without exception foot the list.

Mr. Osborn studied the American population under three different groupings, ethnic, regional, and occupational. Negroes from the South, for example, show a lower intelligence quotient than Negroes residing in the North. Similarly, rural Negroes show an average mentality lower than those residing in urban centres. The quotient rises with the size of the towns and cities, and is highest generally in the metropolitan centre.

Regional and occupational differences, on the other hand, seem to have a direct bearing on intelligence, according to Mr. Osborn's statement when discussing his investigations before the American Eugenics Society in 1933. Thus Negro children from the South after residing for a certain period in urban centres show a distinct rise in their intelligence quotient; and Negroes moving North raise their quotient to practically the same percentage as the rural whites of the South.

Mr. Osborn's conclusions bring out again the superiority of the Pacific states and the Great Lakes-Atlantic seaboard area. Again, and without exception, the South, from Arizona to Virginia, is at the foot of the list. It will be observed that Maine is again low among the northern states.

As in the infantile mortality tables, there are certain apparent anomalies. It may be thought that Wyoming, Colorado, and Montana are unduly high, but each of these states has an extremely large influx from other states or from north-west Europe.

Another very interesting cultural analysis was carried out by Professor Ellsworth Huntington a decade or two earlier, but whereas Mr. Osborn's investigations were statistical only, Professor Huntington's survey, embodied in his famous book on *Civilization and Climate,* included an assessment based on the personal opinion of those well qualified to judge. According to these authorities and also according to Huntington's statistics of education and manufacturing in 1920, the highly cultured area extended from Iowa to the Atlantic and from Washington to California. In the map based on opinion, the Rocky Mountain states occupy a secondary level about like that of the states from Virginia and North Carolina to Missouri and Oklahoma, but not including Arkansas. Utah stands rather low, per-

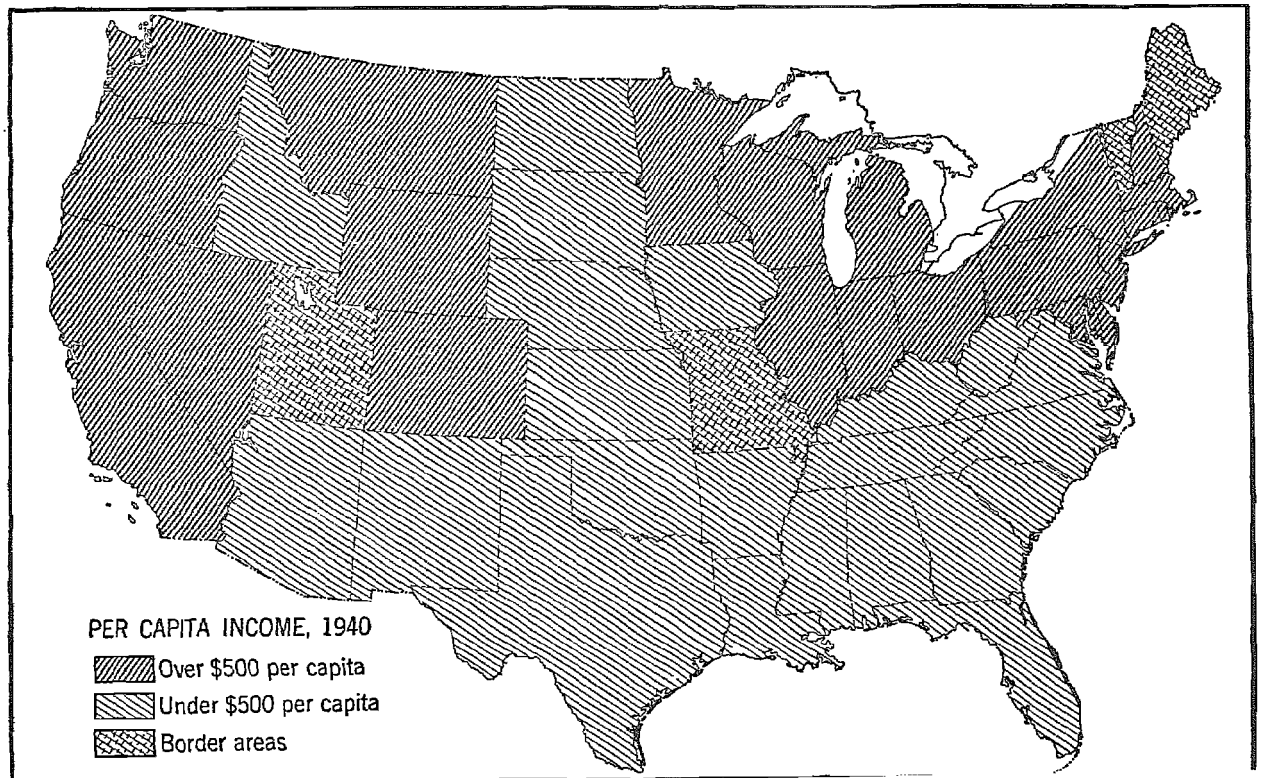
haps because of prejudice, and Nevada falls to the low level of the South in general. In Huntington's educational map, on the other hand, all the southern states except Arizona stand low, while Utah ranks exceptionally high. The impressive thing, however, is the broad agreement about the best areas, though doubtless Huntington's colleagues would now give the Pacific states a higher rating than they secured twenty years ago, and possibly reduce the rating of other areas.

Both Mr. Osborn's and Professor Huntington's conclusions are broadly corroborated by Louis R. Wilson in his *Geography of Reading* (1938, pages 40 et seq.) in which he applies practically the same tests, and gives almost the same grading to the states. Wilson adds an 'Index of Economic Ability' based on diverse factors, which places New York, Connecticut, Massachusetts, New Jersey, Rhode Island, Illinois, and California at the head, and the southern states, without exception, in the lower half. North Dakota and Idaho are lowest ranking northern states. Wyoming, Colorado, and Maine are about half way. In neither Osborn's nor Wilson's inquiries is there any room for personal preferences, for both based their inquiries on the best statistics then available.

C. INCOME PER HEAD

If we turn now to the financial field we find that statistics of incomes and industry have been garnered with especial care. Consequently, in assessing energy by wealth in the United States we have at our disposal a vast armoury of statistics: including a whole library of government publications, and special reports published by commercial or charitable foundations. As some cynic has remarked, it is possible to prove anything in the states if you select the right statistics.

Any assessment therefore of the wealth of states must be above criticism, and I think that of all the information available probably the most reliable is that provided by the National Industrial Conference Board relating to incomes per head. But it is essential here to choose the period with care. A year of bad harvest might show states in the various agricultural belts unduly low on the list, whilst good years might exaggerate their relative prosperity. Again, booms and slumps might unduly


PER CAPITA INCOME, 1940
Over $500 per capita
Under $500 per capita
Border areas

affect the industrial states, particularly when it is remembered that automobile production slumped from 4,800,000 in 1929 to 1,186,000 in 1932 and leapt upward again to over 4,000,000 in 1937.

It is therefore evident that, as with health statistics, a period of years must be taken. The twelve years 1929-40 appear suitable, for they take us from boom to slump, from partial recovery to the forced draught of the New Deal, but exclude the war years. Whichever year or group of years is taken, the order of states is approximately the same: the leaders in 1929 are New York, Delaware, California, Connecticut, and Nevada, and in 1940 Connecticut, New York, Delaware, Nevada, and California, whilst in all years the southern states foot the list. The full list is given in Appendix IV.

The average order of income in the years 1929, 1935, and 1940 shows a striking similarity to that derived from the health and intelligence statistics, but Washington and Oregon are rather lower among the leaders. Virginia and South Carolina among the southern states alone show an improvement over the twelve years, but even with the improvement (possibly due in Virginia to the development of Arlington County as a suburb of Washington and the consequent shift of the population centre of the state further north), they are still in the last fifteen states.

These figures may be compared with the Brookmire Special Report on the *Income of the American People,* 1929-1933. According to this, the leaders over that period were Connecticut, New York, Rhode Island, California, New Jersey, Illinois, and Massachusetts. All the southern states are in the lower half, together with the Dakotas. The full list is given in Appendix IV.

Once again the states with the controllable climates head the list, and those with hot, humid summers are at the foot.

SUMMARY OF THE TESTS

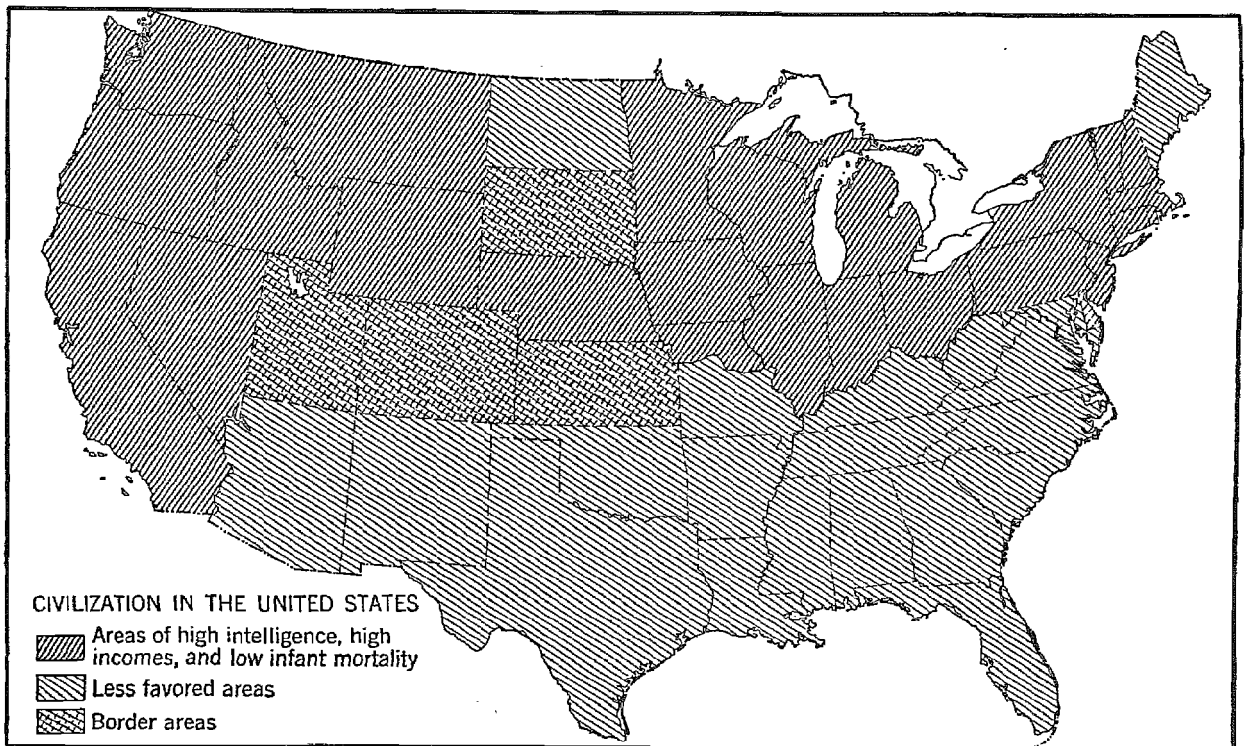
We have now reached a point in our inquiry where we can consider the present energy of the various states and compare it with their climates to see if, as in Europe, progress does depend upon climate and man's control of it.

If we assign an equal value to each of the tests, i.e. assume that superiority in health is as good as superiority in wealth or intelligence, then we are struck by the fact that in the combined table the states with a climate nearest to that of the best European and Australasian areas head the combined list, and that the states with prolonged hot summers or bitterly cold winters make up the lower half.

A combined table, divided into four groups according to the order of merit, and with the states arranged alphabetically in each group, is given below. Mortality, income per head, and intelligence are all taken into account. Maine and North Dakota are the only really northern states in the lower group.

Group I	*Group* III	*Group* IV
California	Colorado	Alabama
Connecticut	*Delaware*	*Arizona*
Massachusetts	Idaho	Arkansas
New York	Indiana	Florida
Oregon	Iowa	*Georgia*
Rhode Island	Kansas	Kentucky
Washington	Michigan	Louisiana
	Nebraska	Maine
Group II	Nevada	Maryland
Illinois	New Hampshire	Mississippi
Minnesota	Pennsylvania	Missouri
Montana	South Dakota	New Mexico
New Jersey	Utah	North Carolina
Ohio	Vermont	North Dakota
Wyoming	Wisconsin	Oklahoma
		South Carolina
		Tennessee
		Texas
		Virginia
		West Virginia

The picture is perhaps brought out better by the map on page 195. If we now compare this with the climatic map on page 176, we are struck at once by the broad similarity; and if we compare them again with the European maps it is obvious that the relation between health, wealth, intelligence, and climate is intimate. In spite of immigration and constant movement, the United States shows the same basic pattern as the older established European communities.



IF THIS MAP WERE EXTENDED TO INCLUDE CANADA, THE ONTARIO PENINSULA AND BRITISH COLUMBIA WOULD BE IN THE 'BEST' AREAS.

PRE-WAR TENDENCIES

There are paragraphs in the preceding section which seem to suggest that as America becomes more Americanized it will lose, or fail to maintain, that drive and energy so characteristic of the 'melting pot' period which ended about 1929, for as is brought out in vital statistics published from time to time, it would appear that the areas of highest Americanization are those of highest infantile mortality, lowest intelligence, and lowest incomes.

This statement, if true, is one of the most astonishing conclusions of our age, and enemies of the United States might sneer that she is a colossus of chromium with feet of clay and that erosion is doing its job. But the truth is that here, as in South Africa, the West Indies, and scores of other places, the climate, particularly where it is hot and humid, is producing the 'poor-white,' whilst the better areas are producing the leaders in invention, health, and efficiency. As the American nation settles down, so does it become more and more obvious that the 16 southern states and the 14 central states are not keeping pace with New York, Connecticut, or California. One of the most astonishing contrasts is seen when southern New England, with its general air of tidiness and energy, is compared with the humid South, with its general air of dereliction and decay. Throughout the South there are, according to Mellett,[3] 21½ million 'below-standard' houses. Houses in the rural South, he says, are the oldest, have the lowest value, and have the greatest need of repair of any farmhouses in the United States. Barely half the houses have electric light; wood is almost the only fuel in many areas, and 'inertia, ineptitude, and unreliability are common.' Over-crowding, too, is a feature of these rural cabins.

Mellett wrote in 1939. His words almost repeat those of passages of the *Carnegie Report* (quoted on pages 136-7 of this book) issued in 1932 relating to conditions among the poor whites of South Africa; and, as in that Report, it is clear that the poor-white problem rarely begins to emerge before the

[3] *Economic Condition of the South*, 1939.

third generation. It may be useful to trace the history of the American family through the last century, beginning with the arrival of immigrant families about 1842, when the number of immigrants first exceeded 100,000 annually, and to see what the psychological and climatological effects have been. The original emigrating young couple left Ireland or Germany (or any one of the other twenty countries that have so liberally supplied America with flesh and blood) for New York and settled in one of the states between the Atlantic and Chicago, and for the next thirty years they gave their best to their new country, and usually reared a large family. Whatever their country of origin they usually took pride in their new land and strove to make their children good Americans. The sons and daughters reacted very rapidly to the new environment and there was little trace outwardly either of the European tongue or way of thinking.

All changes to a greater or less degree are stimulating, and there is no question but that the first or 'naturalized' generation found a great stimulant in the change. To the Irishman coming from the dull, mild cloudiness of Erin, the sharp clearness and bright sunshine of Ohio, Indiana, or Illinois, together with the new way of life, provided a tonic and a stimulant of no mean description. But when the sons moved west the change was much less—merely an emphasis—winters were more severe, summers even hotter. Like their parents the 'second generation Americans' began to feel the strain of assimilation and adjustment but without the stimulus. Many were truly uprooted and demoralized, and their new environment produced curious stresses. The second-generation American presented more problems of violence and crime than the first—a phenomenon which was assisted by the multiplicity of laws.

The third generation, born and bred in this atmosphere, had much of the restlessness of its parents, and perhaps an even greater avoidance and contempt for things European. Grandfather was seldom an object of veneration—and indeed there was scarcely time to sentimentalize about the past. Movement accelerated rapidly, and the cartoonist was not far wrong when he depicted Mrs. Third Generation American saying to her husband, 'John, it's time we moved. I'm beginning to know our neighbours by sight.'

This restlessness was accelerated by other natural causes such as drought or soil exhaustion. Many of the leading agricultural authorities in the United States have drawn attention again and again to the frequent changes of farms, and the entire replacement of populations in the course of a single generation. In western Kansas two-thirds of the families who lived there in 1895 had left the area 10 years later, and by 1935 only a tenth of them were still in the same township or had sons living there. In the depression of 1930-33 and since, this migratory urge was aided by the car and trailer, and thousands more left the Great Plains area to join the ragged ranks of the seasonal workers in the orchards and vegetable fields of California, or to settle on poor cut-over lands of the Northwest or the Ozarks. Great areas like the San Joaquin Valley produced towns based on trailers, and a decade later during the war years the shortage of housing from Detroit to Norfolk gave a new importance to a normadic-industrial life. But whatever numbers moved on to California, Oregon, or Washington, thousands remained, and gradually many of the states began to show a vast increase in the number of third-generation families, and a lessening influx of immigrants to such an extent that they became only a small fraction.

The question naturally arises, how far does America owe her greatness to the stimulus of immigration? How much does she owe to the joint working of peoples from different backgrounds on new problems? And will she, as she becomes more and more American, advance any further or gradually lose her high place among the nations of the world?

Before working this out, it may be advisable to consider past and present trends, but here we are limited to a bare forty years of reliable statistics.[4]

In the fields of population and financial power, there is no question but that the United States has increased her strength more proportionately than any other great power. But in income *per capita* she has already been passed by New Zealand, and in pre-war years was being overtaken by Britain and Australia. Authorities such as Colin Clark seem to think that the United States has already attained or passed her maximum and

[4] Accurate health and industrial statistics date from about 1900, but census figures of course go back to 1790.

that 1929 showed a greater level of peace time prosperity than has been attained since.

As Clark says in his *Conditions of Economic Progress,* page 159, 'There appears to be some powerful force holding down or even reducing the standard of living actually attained by the American population.' On the other hand, in Scandinavia, Australia, Britain, New Zealand, and particularly in Japan there have been significant advances.

If the figures of world trade are taken, there was a similar static tendency observable. In 1913 the *per capita* value of foreign trade of the United States was approximately $36. In 1929-33 it was $38, and in 1936 $30. To put it in another form, in 1913 the United States with a population of 95,512,000 accounted for 12.3 per cent of the world's exports and 8.3 per cent of the imports. In 1936, the percentages were 11.6 and 10.9 but the population had increased to 128,429,000. Although her population had increased faster than that of other nations, her proportion of world trade had remained almost the same.

Clark further quotes the percentage increases of industrial production between 1929 and 1937 (page 66), and here again the United States showed a static tendency:

PERCENTAGE INCREASE, 1937 OVER 1929

(1929 = 100)

Russia	240
Japan	174
Sweden	146
Norway	132
Great Britain	126
Germany	123
Canada	104
Holland	102
United States	102
France	75

Short-term economic and political factors obviously affect these figures to a greater or lesser degree; nevertheless they are very striking.

In health statistics, however, the figures of the death-rate and in particular the infantile mortality rate have improved greatly over the last thirty years, but relative to progress in other parts

of the world there has been little change, and the United States is still seventh in healthiness among the nations.

It would be easy to draw facile conclusions from statistics such as these, but, as many a manipulator of the stock market has found to his cost, it is never safe to predict the future from past trends. Nevertheless I think we may come to certain tentative conclusions. During the past two or three hundred years the United States by virtue of her natural wealth and her freedom has attracted millions of people from Europe, each from a different climatic background. Their differences, their rivalry, and their co-operation have produced the most experimental and most inventive nation under the sun, a nation quick to adopt new ideas, but impatient of restraint. All the time the various climates and climatic controls used in the United States have been at work. In the worst areas, deterioration is evident; and on the other hand the Great Lakes-Atlantic area has progressed apace, and the Pacific Coast is building up a new civilization with a drive and exuberance second to none.

In this connection it is worth while pointing out that it is the southern states which are breeding fastest, and that in the South it is the Mexican and Negro who head the fertility lists. This factor may indeed be one of the most important in the future of the United States. Sociologists such as Osborn and Huntington have already pointed out that given the same chances or opportunities (and I would add the same climatic controls) as the white, the Negro or Mexican is capable of infinite advance. One has only to compare photographs of the educated northern Negro with those of the native West African to realize how far the Negro has come in three centuries, and he has come that distance not in the finest climatic areas, not with the best climatic controls, for to him have been relegated the meaner jobs and the worst buildings. The northern Negro has come thus far in a climate which, while not comparable with that of north-western Europe or the Pacific states, is infinitely superior to that of the Gold Coast or Liberia. In the past the ranks of the whites have been increased by a million immigrants yearly, but what was once a great stream is now a trickle of less than 50,000 yearly. Among the whites the birth rate has been below 17 per 1,000 population most of the time since 1931, while among the Negroes the rate is about 21 and

among Mexicans about 25 per 1,000. There are indications that the coloured population will increase its proportions and power in the near future.

To put it in another form, states south of the 75° summer isotherm have a birth rate of well over 20 per 1,000 population, while states with the best climatic conditions average about 15 per 1,000. The following table showing states with the highest and lowest birth rates for 1938-40 indicates that states in the north-western interior with especially cold winters, such as North Dakota, Wyoming, and Montana, also have high birth rates. Of course the dominance of agriculture in the South and in the north-western interior has much to do with the birth rate. This, however, merely introduces climate indirectly, for other evidence seems clearly to show that the industrial mode of life progresses most rapidly where the climate is most controllable.

Highest Birth Rate		*Lowest Birth Rate*	
New Mexico	27.6	New Jersey	13.8
Utah	24.5	New York	14.2
Mississippi	24.3	Connecticut	14.3
North Carolina	22.7	Massachusetts	14.5
South Carolina	22.7	Rhode Island	15.1
Arizona	22.7	Illinois	15.4
West Virginia	22.3	California	15.6
Idaho	22.1	Oregon	15.7
Alabama	22.0	Washington	15.9
Kentucky	22.0	Missouri	15.9
Louisiana	21.2	Kansas	16.0
Georgia	20.7	Ohio	16.3
North Dakota	20.6	Maryland	16.3
Virginia	20.0	New Hampshire	16.6
Montana	19.9	Pennsylvania	16.6

The pattern parallels that of Europe: the better the climatic conditions and the higher the standard of living, the lower the birth rate. It will be noted that, as in the other tables, North Dakota, with its neighbours, Montana and Idaho, stands out conspicuously as a northern state which has what may be called a southern character in certain respects. Twenty years ago the situation was vastly different, for then states such as New Jersey, Connecticut, California, Illinois, and New York all had a birth rate of over 21 per 1,000, while New Mexico, Mississippi, and

apparently Georgia were about the same as in 1938-40, if the somewhat sketchy statistics of the earlier period are to be trusted.

On this analysis it would seem that in the future the South and the north-west interior and to a less degree the centre of the country will be fruitful in numbers, but relatively static in civilization. But all the time there is the inner migration from the South to the Northeast and the West, in a rather bewildering pattern. I think it is beyond question that the Pacific states will bound ahead both in civilization and numbers. Indeed, before this century is out, the Coast states may have a population of 30 millions and Los Angeles may become the largest city in the United States. The whole of this area is being helped not only by a superb natural climate, but by its ready and intelligent welcome of air conditioning—to which a fuller reference will be made in the next chapter.

It is worth noting that the first Californian, an Iowan by birth, was elected President of the United States in 1929. Although his presidency was not particularly distinguished, it may well be a convenient date for historians to mark as that of a great turning point in American history, the date of the beginning of intellectual domination by the Pacific states. Already their films influence world habits and thought, their novels and songs appeal to the whole of the English-speaking world; their fashions are copied from Vancouver to Valparaiso, and their planes are seen in all five continents. Civilization moves on.

XV

AIR CONDITIONING

Of all the developments that affect indoor living conditions in the United States, and indeed in all areas with hot summers, none is more important than the 'air conditioning,' which in popular conception is any machine-made method of cooling a building, but in effect is so much more.

Air conditioning may be said to have begun with the first prehistoric man who built a fire in his cave, and so in a crude and unscientific way 'conditioned' the air of his immediate environment to his liking. And every development since, whether in the form of heating, drying, cooling, damping, or moving the air, or even of building or glazing, may be classed under the general heading of air conditioning, for they all help to 'condition' the air. To these must be added also dust exclusion, controlled air pressure, and controlled radiation. In short the whole field of control of air indoors might be regarded as air conditioning; yet it is a peculiar thing that the term 'air conditioning' was not applied to even a part of this overall purpose until 40 years ago (1907), when Mr. W. S. Cramer of Charlotte, North Carolina, coined the expression in the course of a paper on humidity control for textile mills, delivered before the American National Cotton Manufacturers Association. Mr. Cramer was, however, only giving a new and indeed a very applicable name to a practice which had begun centuries earlier in India. Hundreds of years ago the Moslems had discovered that wet matting placed on the windward side of windows or doors reduced the temperature considerably (in fact by as much as 15° or 20°), and many and ingenious were the water troughs and channels they made to produce a constant trickle of water over these *kufsas*. There was not, of course, anything but the simplest control of temperature or humidity by this method; either the water trickled down and the wind blew in the right direction, or they did not. There was no

means of controlling the force of the wind, the humidity, or the heat.

Even as far north as Chitral this primitive method of air conditioning is still to be found, and I remember with what surprise I noticed similar arrangements to these in the Mehtar's palace at Kila Drosh in 1921.

The first scientific air-conditioning plant in history was made for the British Houses of Parliament in 1836. It will be remembered that the old seventeenth-century Houses of Parliament were burnt down in 1834 (excepting Westminster Hall and the Crypt, which to this day have no permanent heating systems), and when the design for the new Houses was decided upon, an approved part of the plan was an elaborate system of heating by steam coils, of ventilation by fans, of cooling by water sprays suitably cooled by ice, and of cleansing by forcing the air on foggy days through thick layers of cotton wool. The system had several drawbacks, under which I suffered for years. The air intakes were situated on the Terrace only a few feet above the Thames, which has a peculiar and fishy odour at times; and there was little actual control of humidity, which was often excessive. Moreover the 'fresh' air was infiltered into the Chamber through the floor, which was an iron grill covered by dusty drugget. In addition to this the air change was decidedly slow, and at the end of a crowded debate conditions in the Chamber were often unbearable. Every summer, as the indoor conditions grew more humid or oppressive, honourable members would put down questions to the Minister of Works urging improvements, but with typical British caution nothing was done until in May 1941, when the Germans put an incendiary bomb or two on the roof, and we spent the next few months clearing up the mess and dismantling the now useless conditioning system.

All of this, of course, was done under the good old title of 'Heating and Ventilation,' and, as has been remarked above, it was not until 1907 that the term air conditioning was created by Mr. Cramer and its commercial implications realized by men like Mr. Willis Carrier of Buffalo. Indeed, Mr. Cramer and Mr. Carrier may be said to be the originators of the science of air conditioning with its especial emphasis on humidity control, cooling, and dust exclusion, for they both developed,

apparently independently, different systems of humidity control for the textile industry and dust exclusion for the paper industry in the early years of the nineteenth century. Thus for all general purposes we may accept 1907 as being the year of birth of air conditioning with its implied control of humidity and of both coolness and warmth.

In 1911 air conditioning became a recognized branch of engineering, for in that year Dr. Carrier read two papers on the subject before the American Society of Mechanical Engineers, in which he discussed among other things the design and operation of air-conditioning equipment.

Gradually the demand for this equipment grew; it was undoubtedly saving time and health in the dustier industries, and rendering textiles, paper, and other materials more pliable for manufacture. The pace accelerated during World War I, and was helped by the swift development and the consequently greater ease of refrigeration and cooling.

In 1922 the first moving-picture theatre to be air-conditioned opened its doors in Los Angeles; and another world revolution had begun. Its success was instantaneous; and within the next twenty years every important cinema theatre in America and Europe was air-conditioned. By 1930 the new devices had been adapted to Pullman trains, ocean-going liners, and a vast range of buildings, from offices to department stores. By 1938 simple domestic sets were available for about $150, and cities such as Washington and Los Angeles eagerly adopted the newest of climate controls.

We must now consider briefly 'how it's done,' and the first important point to bear in mind is that no matter what part of air conditioning we consider, whether it be heating or cooling, drying or moistening or cleaning of the air, all have a long history: what is new is the automatic control.

Let us take heating to begin with. The history of the Romans shows what clever heating engineers they were; their early methods of putting the furnace in the basement and having hot-air flues under floors and in the walls give an age-long precedent to the radiant heating engineer of to-day. To come to later periods, the development of central heating systems in the early part of the nineteenth century and of heating by electricity a few years later all preceded 'air conditioning' by

scores of years. There is not a heating unit in any air-conditioning set which does not owe a great deal to the work of Faraday, Swan, and a hundred other scientists working over a century ago. As far as scientific cooling is concerned, we can likewise go back a century or more. Indeed the word 'refrigerate' in the sense of cooling dates from 1471 and there are subsequent examples of its use indicating a health-giving controlled or invented coolness by means of ice or cold well water. In 1755 Dr. Cullen, a Scot, produced cold mechanically by evaporating water in a vacuum, and showed that greater cold could be produced at will by evaporating sulphuric acid, ether, or, and more important still, ammonia. His theory can be demonstrated very simply, for if we take two ordinary thermometers and cover the bulb of one with linen, which is then dampened, the 'wet bulb' will show a temperature of several degrees below the dry bulb in ordinary weather. It is this simple device which is one of the modern ways of testing humidity, but it might also be regarded as proof of the truth that gases, passing from a liquid to a gaseous state, absorb heat. But for many years no one took practical advantage of Dr. Cullen's theory, and the only economic method of refrigeration was to do as the Red Indian had done, and try to conserve natural ice as far into the summer as possible for refrigeration. When Thomas Jefferson built his home, Monticello, he added a vast semi-underground ice house, which was filled with ice late every winter from a near-by lake, every layer being packed around with straw or sawdust. This with care would supply him with ice throughout the next summer. In 1799 the great demand for ice in the southern states of the United States and the West Indies was met by the first shipment of ice from New York to Charleston, S. C., and from there to the West Indies.

In the next half century there were many attempts at refrigerating machines, some of which, like that invented by Maudslay and Field, really worked. In 1846 Dr. John Garrie of Florida produced a 'cold air machine,' and the first artificial ice-making plant was opened at Shreveport, Louisiana.

Meanwhile in Europe scientists were studying Dr. Cullen's experiments, and in 1850 we find Carré in France inventing the ammonia absorption process, which was to be a great factor in the future of refrigeration and air conditioning. In 1875

Linde in Germany introduced the atmospheric compression machine, which proved that compressed air creates cold—as anyone who can deflate a motor car tire can easily prove for himself.

These two European developments, the ammonia system and the compression system, form the basis of our present-day household refrigeration, with electricity as its motive force.

Meanwhile an American who had emigrated to London (strange but true!) had invented an ice-making machine of his own in 1834, which, after a great deal of improvement by other inventors, became a practical machine. The man was Jacob Perkins, known to all stamp collectors as the engraver of the first postage stamp in history, the famous 'Penny Black,' who has already been mentioned as the great developer of central heating. Born in Massachusetts, he became a bank-note engraver, but not meeting the success he deserved in the United States he packed up all his dies and tools and arrived in London in 1818; he later founded the famous firm of Perkins, which produced British stamps until 1880. Following this success he turned after 1823 to experiments with steam warming and ventilation, and indeed might be regarded as the father of central heating, for it was his developments in this field which, improved by his son Angier and transferred to the United States in 1841 by William Nason, became the foundation of present central-heating practice. Jacob Perkins died in 1849 and was buried in London—a notable example of a young American who found his greatest opportunity in Britain.

A few years later the development of the railways caused attention to be directed to the refrigeration of fruit, fish, and meat, and in 1857 W. W. Chandler, an American, produced the first insulated railroad car, to be followed ten years later in Detroit by W. B. Sutherland's refrigerator car.

For thirty years refrigeration stood at this level, with small practical improvements. Then in 1880 came two very important developments: refrigeration in steamships and a more practical type of refrigerator car, which permitted the shipment of meat and fruit from one hemisphere to another.

These developments were rapidly followed by others, based upon the use of electricity and newer liquids and gases, and by the early part of the twentieth century the world stage was

set for the advent of air conditioning. I will not weary the reader with the overpoweringly long list of patents and devices that have brought air conditioning to its present level: suffice it to say that they are mainly American in origin, and that it is America which is most rapidly adopting the new controls.

Perhaps one of the most important of the electrical developments was that of the electric fan, which is an essential unit in any air-conditioning machine, for it is this which impels air through filters or screens, over hot pipes or cold pipes, and so finally ventilates the chamber or hall. Without the fan or some other method of air propulsion, air conditioning would still be an uneconomic ideal.

From Connecticut to Florida and from Portland to Los Angeles there is scarcely a large cinema, department store, or hotel which is not now air-conditioned. At Washington the great new government building known as the Pentagon is the largest air-conditioned building in the world. In Chicago, St. Louis, and scores of other great cities air-conditioned blocks of apartments were springing up before the war. This development may, and I think it will, change the whole course of history in the United States. States like Virginia and Pennsylvania will benefit greatly by the new controls, and the Mason-Dixon line, instead of being the boundary between initiative and conservatism, may become the axis of culture in the postwar America. The greatest contribution to civilization in this century may well be air conditioning—and America leads the way.

But the influence of this new development should not be overrated. It is undoubtedly a great boon in Washington, D. C., New Orleans, Dallas, Houston, St. Louis, New York, and Los Angeles, which are the most air-conditioned cities in the world; but its influence ceases on the doorstep, and there is no indication as yet that air conditioning will help the rural South. As against cold, man had the great advantage that activity helps to overcome its effects. But against heat, especially the humid heat of the Mississippi Valley or the South Atlantic states, activity adds to one's feeling of malaise. Until air-conditioned tractors and jeeps are made, the southern rural workers are likely to remain very much as they are to-day.

But it should not be forgotten that air conditioning depends almost exclusively at present upon electricity for its motive

power, and it is therefore obvious that it will be restricted for many years to those countries which have adequate and economic supplies of electricity. If we glance back at page 104 of this book we shall see that Norway, Canada, Sweden, and Switzerland have the greatest *per capita* production, but none of these have summers of such warmth as to render household air conditioning a necessity. Of the countries with sub-tropical areas, the United States, South Africa, and Australia alone have the basic supplies necessary. The spread of air conditioning will depend mainly upon the development of the electrical industry, and that may well take a score of years or more in the sub-tropics, or even in countries such as Spain or Russia. As for Brazil, India, or tropical African countries, whilst air conditioning will greatly mitigate climatic stress for the wealthy, it will never give to those countries the natural climatic advantages possessed by New Zealand, the Pacific coast, or the northern Mediterranean countries.

XVI

WHAT OF THE FUTURE?

THIS book was written and ready for the press just before the outbreak of World War II. After many delays it was first published in 1942—a small edition that sold out within a few weeks. The second edition, much enlarged, did not see the light until November 1944, and this too sold out in a few months. Meanwhile, from all over the world I had received letters full of suggestions and helpful criticism. In the first edition, I predicted that Germany would lose the war, and I gave my reasons for this, which have since proved accurate. As this work shows, the energy behind Germany was never sufficient to give her potential superiority at any moment of the war. Had she been able to enlist the support of Russia, as seemed likely for a time in 1940, she might have made a longer war, but against the punching power of the Allies she was bound to be defeated at last.

We now face a long peace—apart of course from sporadic local outbreaks in Asia Minor and comparable areas where tension is always high. In the roll of nations the United States heads the list in power and influence. As to who is second there may be much argument, but in my view there is no doubt that as matters stood in 1945, Britain was undoubtedly second, and Russia third. In sheer civilization, though not in punching power, New Zealand, Australia, the Netherlands, Switzerland, and Canada head the list, as is brought out on page 128. All of these countries and Scandinavia will forge ahead in the future, and the pace of their advance will be approximately that of their increase in electric power as indicated on page 104. In the United States, progress will be erratic and sporadic. The dry, champagne-like atmosphere of most of the middle west and the north-east is one that lends itself easily to tension. In former times this would have had the outlet of war; to-day it finds its outlet in industrial disputes. It is significant that the

automobile industry is located mainly in an area where owing to climatic conditions, tempers are more easily frayed than elsewhere. In former times the tragic sequence was War—Poverty—Peace—Plenty—War; to-day the sequence is more likely to be Industrial War—Temporary reduction of the standard of living until one side or the other gives in—Industrial Peace—Rising standard of Living—Industrial war again. Unless the United States can evolve some method of settling its labour-capital disputes without recourse to strikes or lockouts, she may jeopardise much of her progress.

There were other indications before the war of this nervous tension. Areas that become distressed mainly through climatic causes (though erosion also has much effect here) create waves of emmigrants. The more fortunate areas, such as California, become their goal. California wanted neither 'Okies' or 'Arkies,' and there occurs something like a hold-up on the roads leading into the state. As the population increases and the cultivatable areas decrease (in spite of irrigation projects) these tensions are bound to grow. Nobody nowadays wants immigrants who are down and out, and the Pacific states are no exception. Of all the countries I have visited and studied, the United States seems to present the biggest problems. But as she has the biggest everything else, perhaps it is only justice! But the fact is that if these problems are affected by bad temper on both sides, much of the tremendous potential of the United States may be lost.

Britain, Scandinavia, New Zealand, and Canada also have comparable problems, but there is less tension in the air, less champagne for the spirit, or bellows for the fires of wrath.

Germany and, of course, Japan present different problems. Germany has been defeated utterly—but Germany survives. That great space between France and Poland will continue to produce a race high in optimum values. Sixty million industrious Germans will never be kept down, no matter what the peace treaty. I predict that within a few years, ten or twelve at most, the growing might of Germany will again interest the world. Hitherto, much of her energy has been devoted to war, and since Bismarck's day her potential has been masked by the fact that millions of her people yearly have devoted their whole time and energies to destructive ends. And yet in the half-century before Bismarck this area was one of the most peaceful

in Europe. Germany's future depends upon whether she has learnt a lesson—the lesson that war does not pay, not even the winner; but in 1946 in Germany I found singularly few Germans of this frame of mind. The general feeling was that if Hitler had concentrated on the atomic bomb instead of the rockets, Germany would have won the war—and then . . . !

But the point I want to reiterate about Germany is that this area is one of the best in the world for human energy, and that Germany will rise again in our own generation.

France, by contrast, has for years been a declining force. By birth control she has so restricted her population that from being the greatest Western European power (as she was up to 1814) she is now fourth, and the melancholy tale is not yet finished. Here is a country of old men and women and few children. The energy should be high, for all except the south is first class from the point of view of human energy, but old men's veins run sluggishly. In 1780 France had about twice the population of Great Britain, or what is now Germany, and five times that of the U. S. A. To-day she is the weakest of the four numerically, and weaker still qualitatively. France recognises all these things, and her bookstalls are full of pamphlets calling for more children, but the French wife of to-day looks at her rations, at the cost of everything, especially fuel, and leaves to her neighbour the task of bearing another little Pierre or Marie.

Russia is our greatest conundrum. So little reliable statistical information comes out of Russia that our best data are but a series of intelligent guesses. Nevertheless, Russia, by her acquisition of Latvia, Esthonia, Lithuania, eastern Poland, Bessarabia, part of Finland, and other areas on her western borders, has added immensely to her strength, for all of these areas were more energetic, more healthy, and more prosperous than most areas of Russia proper. Her population has increased to about 200,000,000, and given heating apparatus at anything like American standards there is no doubt but that her energy would be greatly increased. In the pre-war years, Russia was advancing very fast, and great cities such as Moscow were leading the world in terms of experiments in district heating.

But factors other than land acquisitions, heating systems, or numbers help to shape world history, and not the least of these is man's migratory habits. In late years Russia has, as a matter

of national policy, sited certain industries (and consequently many tens of thousands of families) in areas much less favourable climatically than her western margin. The new centres at places like Magnitogorsk and Cheliabinsk have the most severe winters imaginable. The generation of Russians that is growing up within sight of the Urals will have to endure climatic extremes much wider than those in the older centres of population.

Similarly in South Africa, Canada, and Australia there appear to be movements inland, and even as the Karroo is already taking its toll of South African efficiency, so may the Prairie Provinces and Queensland take their toll of Canadian and Australian efficiency. Winnipeg, for example, has one of the hardest climates in the world, surpassed in inclemency only by Siberia and the interior of Greenland; in 1871 its population was 241; to-day it is 220,000. Calgary, too, with an equally hard climate, was non-existent in 1881; to-day its population is 84,000. Fifty years ago the total population of the Prairie Provinces was about 100,000; to-day it is over 2,530,000. Winters all over this area are twenty to thirty degrees colder than winters in Toronto.

Similarly, in Australia, the population of Queensland has increased from about 200,000 in 1881 to over 1,000,000 to-day, and at Brisbane the mean temperature of the coolest month is 58.5° F. and of January is 77° F., accompanied by high relative humidity.

In each of these areas the emigrants that have built them up came from more favoured lands; they brought their energy with them, and for a time these areas are bound to reflect that energy. But sooner or later climate will tell. We have seen in South Africa that the 'poor white' problem has developed relentlessly over two centuries, but Queensland and the Prairie Provinces of Canada have not yet been settled extensively for two generations.

Sir R. Cilento and others have urged that Queensland is as good as any other area provided adequate attention is given to housing and sanitation. I would modify this slightly by saying that if Queensland can acquire climate controls against heat and humidity (i.e. air conditioning) it will progress as fast as any sub-tropical area in the world.

The United States is also faced with similar developments. All the area from the Rockies to the Appalachians has a less favourable climate than the New England states; but California, Oregon, and Washington have a climate even better than the latter. If the trend of population is to the Pacific states (as I think it is), the United States will add to its energy, but if it is to the central states, or to the warm moist areas, we may expect a static tendency.

But, as has already been brought out, the United States is solving its problem in another way, for the number of air-conditioned factories, cinemas, shops, and apartment houses was increasing daily up to 1941. Far down in the basement of these buildings, great machines draw in the sticky vitiated atmosphere, filter it through oil-saturated blankets of spun glass or steel wool, wash it, cool it, dry it, and send it up again fresh and brisk. Railways, too, have their air-conditioning plants; over 10,000 railway coaches have been fitted with the new device which provides clean air without draughts.

One company in New York found that air conditioning improved efficiency and freedom from illness by one-third, and in the offices in Rockefeller Center, the Empire State, and Chrysler Buildings, both coughs and traffic noises are excluded. In the immediate pre-war years air conditioning was spreading to private houses.

At the risk of descending to the slightly absurd, I must quote a pre-war advertisement from *The Saturday Evening Post,* advertising a chain of hotels:

> You won't see (or need) a fan in our hotels, even on the hottest days. For we've taken the swelter out of summer. Restaurants, public rooms and convention hall, even a number of guest rooms, at slightly extra cost, are comfortably 'air-cooled.'
>
> Air-cooled, but not too cool. You won't need a fur coat either, or a bottle of cough syrup. Our weather-makers have temperate ideas. And cool you off by degrees . . . 15° or so, just the right number. So you'll find you have more pep and go than you'd have believed possible in summer. You'll be eating from top to bottom of the menu. Dancing till closing time. Sleeping like Rip Van Winkle. And keeping clear-headed and comfortable, even if the Mercury itself gets dizzy with the heat outside.
>
> This summer, whether you're travelling on business or pleasure, better make a point of stopping at one of our air-conditioned oases. You'll find the welcome as warm as the hotels are cool . . .

Allowing a little for the exuberance of the advertisement, the facts are obvious—mankind is on the verge of a development which may alter the whole focus of civilization. Air conditioning is one of the greatest advances of the past century. But whilst it may add to American and Australian efficiency, we must not forget that climate control ceases on the doorstep, and that the natural climate plays its part in affecting human energy the moment we leave the house, railway coach, or motor-car. Thus, the new centres of civilization will not be in the heart of continents, but will remain near the sea. The northern Mediterranean, California, Australia, South Africa, New Zealand, and Japan seems to be the obvious areas as air conditioning develops.

On the other hand there have been considerable recent improvements in the control of cold and damp. As has been pointed out on page 103, whilst coal fires or stoves were in use all over north-west Europe several centuries ago, it was not until early this century that electricity heating, gas heating, and oil heating added so greatly to our environmental control.

There is, however, one curious development in the growing control of climate, and that is the steady tendency to increase the indoor winter temperature. Fifty years ago 60° F. was held to be the ideal, and indeed thermometers can still be bought in chemists' shops in Britain where this is clearly indicated. By 1920 the British ideal was about 64° and by 1939 between 65° to 70° was becoming much more generally accepted for government buildings, offices, and cinemas. In the United States the old ideal of 70° is being replaced by one between 72° and 75°. There is obviously a point in this where the ideal becomes a 'comfort' ideal instead of an 'energy' ideal, and it may be that the best temperatures and humidities are not those in which one feels perfectly comfortable but those in which one feels slightly cool, for coolness is a prime essential to the physical work (including typewriting), without which all mental effort becomes, as the Arab's, mere conversational speculation, barren in result.

As for the British, there is little danger as yet that they will ever cheerfully become 'comfortably warm' rather than 'energetically cool' for unless they be over 60 they still seem to prefer what most Americans regard as barbarically cold houses

or offices. It is only since 1919 that the average Englishman has taken to the electric fire as a means of warming his bedroom, where a not unimportant part of one's day is spent.

In my own lifetime I have seen the average English family pass from a single fire—the kitchen grate or range, with perhaps a fire in the parlour on Sundays—to a state of things where almost any room, from the bedrooms to the bathroom, can be warmed speedily by one or other of modern appliances. And the generation now in its twenties or younger is the first generation in English history to enjoy these amenities. But there are still many English villages where there is neither gas nor electricity, and the proportion rises rapidly in Scotland, Ireland, and Wales.

There is one other point which should not be forgotten: it is that while most of the early forms of climate control were dirty, the new ones are clean. I remember the awful pea-soup fogs which in my youth used to descend on London whenever a calm day in winter held the products of a million chimneys suspended like a great pall over the entire city. Sulphur and carbon in high densities in the air are not pleasant to breathe, to smell or to taste—they are most depressing to the spirit. London or Glasgow in a November fog in the old days was as near a climatic hell as any I can remember. British chimneys still pollute the atmosphere, but to a lessening extent as gas, electricity, and central heating become more widespread. Possibly in another decade or two Britain will get back to that clear sunny pre-Industrial Revolution climate about which Shakespeare wrote so lovingly. Manchester and Glasgow still lose nearly half their sunshine through smoke and fog: and it is a delicious thought that Lancastrians or Scots might become much sunnier were they to change over from old-fashioned open grates to the cleaner modern methods of heating.

Therefore, as heating systems develop further I expect north-west Europe and similar climatic areas to show still better vital statistics, and indeed to continue to lead the world for a generation, but I do not expect their percentage of world trade to increase—for here, I think, Russia, the Argentine, and other nations late in developing and those which take full advantage of the newest climate controls will proceed to take an ever-growing share.

In comparative progress I think the Argentine will take first place. Few realize the great strides this country had made prior to 1940, and this part of the world was one of the few areas untouched by the recent war. Whilst civilization in Europe has had a check of infinite severity, and in North America, Australia, and Japan a relative check, in the Argentine and Uruguay it has been forging ahead. Moreover, the Argentine is rapidly acquiring climatic controls and a sufficient population. Her biggest drawback is lack of adequate supplies of coal and iron, which so far has limited the development of her southern provinces, and she had not very greatly advanced in electrical development up to 1938. During the last five years, however, her electrical development has, I understand, proceeded apace.

Pending the arrival of air conditioning at economic rates, the areas of this world most worth living in from the point of view of energy, health, and efficiency are New Zealand, the Pacific states, south-east Australia, the Netherlands, Switzerland, south-eastern England, and similar climatic areas. When air conditioning arrives, the desirable realms will be slightly farther south (or north in the southern hemisphere), possibly along the 58° or 60° annual isotherms.

We have seen how civilization follows man's control of his own environment. For man is the product of his environment; his energy, his health, his progress depend upon it. In human history, clothing, tools, and the control of cold, heat, and damp replace natural selection. I believe we are on the eve of developments greater than those of the past, for air conditioning, and electrical developments in many forms, will give man not only still greater control of damp and cold, but of heat and dryness, and whilst the desert may not yet blossom as the rose, it may blossom once again with keen alert minds. The Negro may yet reach heights of intellectual attainment undreamt of by Booker T. Washington; the Semite, the Arab, the southern Latin, and the Greek may, by climate control, leap forward again into the van of scientific progress. Possibly, however, new energy may only produce greater antagonisms, for history teaches us that civilization brings new terrors to war, new fevers for riches, new modes of human exploitation. Its greatest lesson is that although climate and climatic control play a tremendous

part in the causation of human energy and consequently of human civilization, it is the spiritual ideals which often direct that energy and shape civilization. From the earliest superstitious fears of Sumeria to the highest religious or patriotic instincts of to-day, these innermost thoughts, hopes, and fears guide and influence mankind. Unless men are won by the spirit, all conquests are vain. The history of all civilizations shows that unless men are united in a common zeal, then sooner or later the forces of disunity will triumph, and in these struggles, civilization receives its severest setbacks. Rome owed much of her success to the loyalty she won from the conquered territories. Mohammedanism won the spirit first and conquered after. Possibly the greatest tragedy of all time is that since the Crusades there has been no unifying influence in north-west Europe, and without spiritual union wars are inevitable.

A glance at the recent history of Europe shows how these things of the spirit determine aspects of world history. Holland and Belgium combined (as they were from 1815 to 1830) might have become an outstanding world power. Norway and Sweden too, united from 1814 to 1906, presented a formidable aggregation of intellect and energy to the world. But Belgium would not admit Dutch mastery, nor Norway, Swedish supremacy, and in place of strong formidable units, much weaker national elements took their place. Conversely both Germany and Italy, in the same century, found a formula which commanded loyalty of the spirit from their citizens. As for the British Empire, it exemplifies both trends. Where Ireland was and is concerned, the spiritual forces lead to disunity; where the overseas white populations are concerned there is a mystic loyalty to the Crown, undefined and indefinable, which has no precedent in all history. But of all nations at all times none have found a formula so satisfying for spiritual unity as the United States. It has indeed been accompanied by material wealth, and it has its eternal question mark of the Negro and other coloured units, but by and large it does represent one of the most successful spiritual amalgamations in history.

These forces of religion or nationalism, call them what you will, arise from the desire in most men to have something beyond themselves for which to work. In its altruistic shape this produces the loveliest things ever known—and the loveliest

characters; in its less desirable shape it produces some of the greatest scourges of mankind.

In short, whilst optimum climatic conditions and controls produce men of the greatest energy, the final direction of that energy, be it for good or ill, is determined by inner thoughts, fears, or hopes expressed through the ballot box or bullet, through treaty or terror, according to the spiritual values of the age. Is it too much to hope that, when all men can enjoy the serenity of ideal indoor conditions, the thirst for mortal power will give place to the thirst for mental poise, and to the lust for light?

In the past mankind has blundered into civilization. With the knowledge before us we know that the populous nation which can keep its citizens, all its citizens, in ideal climatic conditions, whether indoor or outdoor, will have a great opportunity to lead the world in health, energy, trade, and culture.

APPENDIX I

Climatic Conditions of Various Countries

Country	Population 1931	Mean Annual Temp. °F.	Coldest Month		Warmest Month		Range °F.
			Temp. °F.	Relative Humidity per cent	Temp. °F.	Relative Humidity per cent	
Russia in Asia..	40,000,000	34.0	−1	..	67.0	..	68
Russia in Europe	124,000,000	40.0	16.0	76	65.0	71	49
Finland	3,486,000	40.4	20.0	88	63.0	73	43
Esthonia	1,122,000	40.6	21.0	88	63.0	73	42
Latvia	1,900,000	42.8	23.0	87	64.0	72	41
Norway	2,829,000	43.0	27.0	84	62.0	70	35
Sweden	6,142,000	43.0	28.0	86	62.0	68	34
Lithuania	2,350,000	43.2	26.0	89	66.0	76	40
Canada	10,377,000	44.0	18.0	82	68.0	72	50
Poland	32,133,000	46.0	26.0	87	66.0	72	40
Denmark	3,574,000	46.0	31.5	88	62.0	75	31
Germany	64,900,000	48.0	32.0	85	65.0	71	33
Czechoslovakia..	14,935,000	48.0	29.0	85	66.0	70	37
Switzerland	4,097,000	48.5	32.0	85	65.7	72	33
Belgium	8,122,500	48.5	35.0	86	63.0	76	28
Austria	6,720,000	49.0	30.0	83	67.5	67	37
United Kingdom	46,037,000	49.0	40.0	86	61.0	74	21
Irish Free State.	2,969,000	50.0	43.0	86	60.0	81	17
Hungary	8,750,000	50.0	28.3	86	71.3	62	43
Netherlands ...	8,036,000	50.0	37.0	89	64.0	76	27
Roumania	18,250,000	51.0	26.0	84	73.0	60	47
Bulgaria	5,900,000	52.0	30.0	82	71.0	65	41
U.S.A.	124,000,000	52.0	31.0	77	73.0	69	42
California ...	6,000,000	58.0	49.0	71	69.0	75	20
North-east * ..	60,000,000	51.4	29.0	73	75.0	68	46
South-east † ..	12,000,000	64.0	48.0	79	78.0	77	30
Yugoslavia	13,934,000	53.0	32.0	80	72.0	62	40
France	41,835,000	53.0	39.0	85	68.0	69	29
New Zealand...	1,519,000	55.5	48.0	81	63.0	74	15
Chile	4,300,000	56.5	48.0	82	66.0	61	18
Japan	65,312,000	57.8	38.0	69	79.0	79	41
Italy	41,177,000	59.0	42.0	75	76.0	59	34
Spain	23,800,000	59.3	45.4	77	76.4	60	31

* Area north and east of Washington, St. Louis, and St. Paul.
† Area south and east of Memphis. For details see Appendix III.

Country	Population 1931	Mean Annual Temp. °F.	Coldest Month Temp. °F.	Coldest Month Relative Humidity per cent	Warmest Month Temp. °F.	Warmest Month Relative Humidity per cent	Range °F.
Portugal	6,450,000	59.0	49.0	81	69.0	63	20
Persia	9,000,000	59.0	30.0	80	82.0	48	52
Turkey	14,700,000	59.6	42.0	74	76.0	54	34
Mexico *	16,850,000	61.0	55.0	58	66.0	70	11
Argentine	11,672,000	61.0	48.0	84	74.0	72	26
Uruguay	1,955,000	62.0	50.0	77	73.0	66	23
Australia	6,545,000	61.8	52.0	78	71.0	62	19
China	360,000,000	62.0	40.0	72	82.0	81	42
North of 30°	.....	58.0	34.0	73	81.0	81	47
South of 30°	.....	66.0	47.0	72	83.0	82	36
Syria	2,900,000	62.0	48.0	80	76.0	66	28
South Africa	8,281,000	62.5	54.0	66	70.0	68	16
South †	.....	65.0	58.0	85	71.0	72	13
North-east ‡	.....	61.0	50.0	52	67.0	71	17
Greece	6,470,000	63.0	46.0	74	81.0	52	35
Palestine	1,035,000	64.0	48.0	76	77.0	66	29
Peru *	6,500,000	65.0	60.0	79	72.0	86	12
Morocco (French)	5,405,000	65.0	3.0	78	79.0	66	26
South Rhodesia *	1,109,000	66.0	56.6	60	72.0	70	16
Ecuador *	1,950,000	67.0	66.0	75	68.0	79	2
Egypt	14,804,000	70.0	55.0	65	82.0	57	27
Iraq	3,000,000	71.0	48.0	80	85.0	43	37
Kenya *	3,025,000	71.0	67.0	81	74.0	75	7
Venezuela *	3,150,000	71.0	69.0	80	74.0	81	5
Brazil *	42,000,000	72.0	67.0	81	77.0	81	10
Salvador *	1,475,000	73.6	71.4	84	76.3	72	5
British West Indies *	1,640,000	76.0	74.5	79	78.5	74	4
Cuba *	3,962,000	77.0	72.0	76	82.0	74	10
Belgian Congo *	9,500,000	78.0	72.0	69 (Aug.)	81.0	82	9
Liberia *	2,000,000	78.0	74.0	90	83.0	82	9
India *	352,786,000	79.0	69.0	75	88.0	72	19
Haiti *	2,300,000	79.0	76.0	65	82.0	70	6
French Indo-China *	21,452,000	79.0	72.0	79	85.0	82	13
Nigeria *	19,000,000	80.0	76.0	75	82.0	80	6
Ceylon *	5,313,000	80.0	78.0	74	83.0	78	5
British Malaya *	4,350,000	80.0	79.0	82	82.0	76	3
Burma *	14,665,000	81.5	76.0	82	87.0	86	11
Siam *	12,050,000	82.0	77.0	79	85.0	75	8
Sudan *	5,508,000	84.0	73.0	32	93.0	22	20

* Tropics.

† Cape Town and Durban area.

‡ Johannesburg and Pretoria area.

APPENDIX II

Percentage of World Trade per Country and per *Ten Millions Population*

Country	*Population* 1931	*Percentage per Country* 1926-1935	*Proportion per* 10,000,000 *Population*
United Kingdom	46,037,000	13.48	2.94
U.S.A.	124,000,000	12.17	0.99
Germany	64,900,000	8.86	1.37
France	41,835,000	6.63	1.59
Canada	10,377,000	3.08	2.95
Japan	65,312,000	3.06	0.47
India	352,786,000	2.91	0.08
Netherlands	8,036,340	2.9	3.61
Belgium	8,122,500	2.85	3.52
Italy	41,177,000	2.77	0.67
Argentine	11,672,000	2.37	2.03
China	360,000,000	2.18	0.06
Australia	6,545,000	2.01	3.10
Czechoslovakia	14,935,000	1.60	1.08
South Africa	8,281,000	1.57	1.90
Switzerland	4,097,000	1.56	3.81
British Malaya	4,350,000	1.48	3.40
Sweden	6,142,000	1.47	2.39
Dutch East Indies	60,900,000	1.45	0.24
Russia (U.S.S.R.)	164,500,000	1.45	0.08
Denmark	3,574,000	1.34	3.47
Brazil	42,000,000	1.30	0.31
Spain	23,800,000	1.28	0.54
Austria	6,720,000	1.02	1.51
Poland	32,133,000	0.88	0.27
Algeria	6,554,000	0.82	1.25
Egypt	14,804,000	0.77	0.52
Norway	2,829,000	0.76	2.65
Irish Free State	2,969,000	0.75	2.53
New Zealand	1,519,000	0.73	4.80
Mexico	16,850,000	0.68	0.40
Cuba	3,962,000	0.63	1.59
Korea	21,365,000	0.61	0.29
Roumania	18,250,000	0.59	0.32
Finland	3,486,000	0.54	1.54

Country	*Population* 1931	*Percentage per Country* 1926-1935	*Proportion per* 10,000,000 *Population*
Hungary	8,750,000	0.54	0.62
Philippines	12,450,000	0.49	0.39
Chile	4,360,000	0.49	1.14
Ceylon	5,313,000	0.43	0.81
Yugoslavia	13,934,000	0.40	0.29
Venezuela	3,150,000	0.38	1.21
Greece	6,470,000	0.36	0.56
Formosa	4,708,000	0.35	0.74
French Indo-China	21,452,000	0.34	0.16
Turkey	14,700,000	0.32	0.22
Portugal	6,450,000	0.30	0.46
Persia	8,950,000	0.30	0.33
Siam	12,050,000	0.29	0.24
Uruguay	1,955,000	0.28	1.43
Tunis	2,411,000	0.26	1.08
Peru	6,450,000	0.26	0.40
Morocco (French)	5,405,000	0.25	0.46
Nigeria	19,158,000	0.22	0.11
Latvia	1,900,000	0.15	0.80
Bulgaria	5,900,000	0.14	0.27
Esthonia	1,120,000	0.09	0.80
Bolivia	3,000,000	0.11	0.36
Guatemala	2,200,000	0.10	0.48
Sudan	5,530,000	0.09	0.17
Iraq	3,300,000	0.08	0.24
Lithuania	2,320,000	0.08	0.35
Palestine	1,035,000	0.06	0.56
Salvador	1,475,000	0.05	0.33
Haiti	2,600,000	0.06	0.23
Ecuador	2,000,000	0.04	0.20
Paraguay	890,000	0.04	0.45
Nicaragua	800,000	0.03	0.36
Panama	475,000	0.02	0.42

APPENDIX III

United States Climatological Data

State and Largest Cities	*Average Temperature Where People Actually Live* — *Coldest Month* Degrees Fahrenheit	*Warmest Month* Degrees Fahrenheit	*Remarks*
Alabama	46	80	3 months over 75°
Birmingham	45	80	3 " " "
Arizona	42	80	5 " " "
Arkansas	42	81	3 " " "
California	51	70	
Los Angeles	53	71	
San Francisco	49	61	
Colorado	28	70	
Denver	28	72	
Connecticut	26	71	
Hartford	26	71	
Florida	63	82	5 " " "
Jacksonville	55	82	5 " " "
Georgia	48	80	4 " " "
Atlanta	44	78	3 " " "
Idaho	26	68	
Illinois	24	74	
Chicago	23	73	
Indiana	29	76	1 " " "
Indianapolis	29	76	1 " " "
Iowa	21	74	
Des Moines	20	75	
Kansas	31	80	2 " " "
Kansas City	28	79	2 " " "
Kentucky	35	78	2 " " "
Louisville	35	79	2 " " "
Louisiana	53	82	4 " " "
New Orleans	54	82	5 " " "
Maine	19	68	
Maryland and Delaware	34	76	1 " " "
Baltimore	34	77	2 " " "
Massachusetts	28	71	
Boston	27	71	

State and Largest Cities	Average Temperature Where People Actually Live: Coldest Month Degrees Fahrenheit	Warmest Month Degrees Fahrenheit	Remarks
Michigan	24	72	
Detroit	24	72	
Grand Rapids	24	72	
Minnesota	11	71	
Minneapolis	13	72	
St. Paul	13	72	
Mississippi	47	81	4 months over 75°
Missouri	32	79	2 " " "
St. Louis	31	79	3 " " "
Kansas City	28	79	2 " " "
Montana	20	65	
Nebraska	24	76	1 " " "
Omaha	22	77	1 " " "
Nevada	30	73	
New Hampshire	21	69	
New Jersey	31	74	
Newark	30	75	1 " " "
Jersey City	33	76	1 " " "
New Mexico	34	76	1 " " "
Albuquerque	34	77	1 " " "
Santa Fé	29	69	
New York	23	70	
New York	29	73	
Buffalo	25	70	
Rochester	22	74	
North Carolina	41	77	2 " " "
North Dakota	6	69	Lowest −40° February Highest 111° August Coldest winter in United States
Ohio	28	73	
Cleveland	26	71	
Cincinnati	33	78	2 months over 75°
Oklahoma	39	82	3 " " "
Oklahoma City	36	81	3 " " "
Tulsa	37	82	3 " " "
Oregon	39	67	
Portland	39	67	
Pennsylvania	30	74	
Philadelphia	33	76	1 " " "
Pittsburgh	31	75	1 " " "

State and Largest Cities	*Average Temperature Where People Actually Live*		*Remarks*
	Coldest Month	*Warmest Month*	
	Degrees Fahrenheit		
Rhode Island	27	73	
Providence	27	72	
South Carolina	46	80	3 months over 75°
South Dakota	16	74	
Tennessee	40	79	2 " " "
Memphis	41	81	3 " " "
Nashville	39	79	3 " " "
Texas	49	83	4 " " "
Houston	53	84	5 " " "
Dallas	46	84	4 " " "
Utah	27	74	
Salt Lake City	29	76	1 " " "
Vermont	18	68	
Virginia	36	76	1 " " "
Richmond	38	78	2 " " "
Norfolk	40	79	2 " " "
Washington, W. Div.	41	65	
Seattle	39	63	
Spokane	28	69	
E. Div.	30	72	
State	35	65	
West Virginia	34	76	1 " " "
Wisconsin	16	71	
Milwaukee	20	70	
Wyoming	21	68	

It must also be borne in mind that average monthly temperatures, whilst fairly representing conditions near the coast, do not give a true idea of the more inland areas. Thus for example whilst at San Francisco the *daily* variation of temperature is only about 11° F., at Des Moines (Iowa) or Denver (Colorado) it is about 26°. It follows that few inland areas will have a climate as steady as the coastal areas, and that averages of monthly temperatures may be extremely misleading.

U. S. EXTREMES OF WEATHER

(From *Climate and Man,* page 664.)

Lowest temperature on record in the United States, −66° F. at Riverside Ranger Station, Wyo., in Yellowstone Park, 9 February 1933.

Highest for the United States, 134° F. at Greenland Ranch, Death Valley, Calif., 10 July 1913.

Average annual precipitation for the United States, approximately 29 inches. Wettest state, Louisiana, with an annual rainfall of 55.11 inches. Driest state, Nevada, averaging 8.81 inches annually. Highest local average annual rainfall in the United States, 150.73 inches at Wynoochee Oxbow, Wash., based on a 13-year record.

*Extreme minimum rainfall records in the United States in*clude a total fall of only 3.93 inches at Bagdad, Calif., for a period of 5 years, 1909-13, and an annual average of 1.35 inches at Greenland Ranch, Calif.

Heavy snowfall records include 60 inches at Giant Forest, Calif., in 1 day; 42 inches at Angola, N. Y., in 2 days; 54 inches at The Dalles, Ore., in 3 days; and 96 inches at Vanceboro, Maine, in 4 days.

Greatest seasonal snowfall, 884 inches, more than 73 feet, at Tamarack, Calif., during the winter of 1906-7.

APPENDIX IV

Annual Income in Dollars per Head in the United States, 1929-40

State	*Estimates made by the National Industrial Conference Board*				*Brookmire estimate of*
	1929	1935	1940	*Average* 1929-40	*average for* 1929-33
New York	1,080	700	829	869	743
Delaware	1,022	592	803	806	680
Connecticut	892	607	840	780	749
California	942	605	748	765	716
Nevada	879	545	771	732	648
Illinois	853	500	685	679	702
Massachusetts	806	539	681	675	694
New Jersey	801	517	701	673	715
Rhode Island	773	561	643	659	725
Wyoming	706	526	622	618	631
Michigan	741	473	620	611	613
Pennsylvania	731	478	602	604	663
Washington	709	434	626	590	569
Ohio	690	460	616	589	633
Maryland	677	473	614	588	552
Montana	638	482	570	563	605
Wisconsin	643	467	570	560	588
New Hampshire	592	438	570	533	566
Oregon	643	394	560	532	536
Colorado	621	406	522	516	530
Minnesota	555	416	553	503	521
Indiana	566	402	541	508	570
Maine	588	415	483	495	513
Arizona	616	402	445	488	483
Missouri	582	366	496	481	484
Vermont	577	365	473	472	559
Idaho	551	345	459	452	510
Utah	549	348	445	447	441
Kansas	532	365	449	449	531
Nebraska	550	361	426	446	590
Florida	510	352	465	442	355
Iowa	498	370	445	438	617
Texas	457	316	411	395	384

State	*Estimates made by the National Industrial Conference Board* 1929	1935	1940	*Average* 1929-40	*Brookmire estimate of average for* 1929-33
West Virginia ..	450	318	414	394	405
Virginia	402	305	419	375	340
New Mexico ...	413	321	372	369	346
South Dakota ..	451	275	353	366	461
Louisiana	386	300	395	360	303
North Dakota ..	479	260	335	358	366
Oklahoma	432	259	355	349	345
Kentucky	363	240	336	313	252
Georgia	327	253	315	298	221
Tennessee	350	232	297	293	246
North Carolina..	306	252	306	288	313
South Carolina..	263	224	300	262	201
Alabama	303	189	257	250	192
Arkansas	294	182	250	242	185
Mississippi	268	170	198	212	160

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